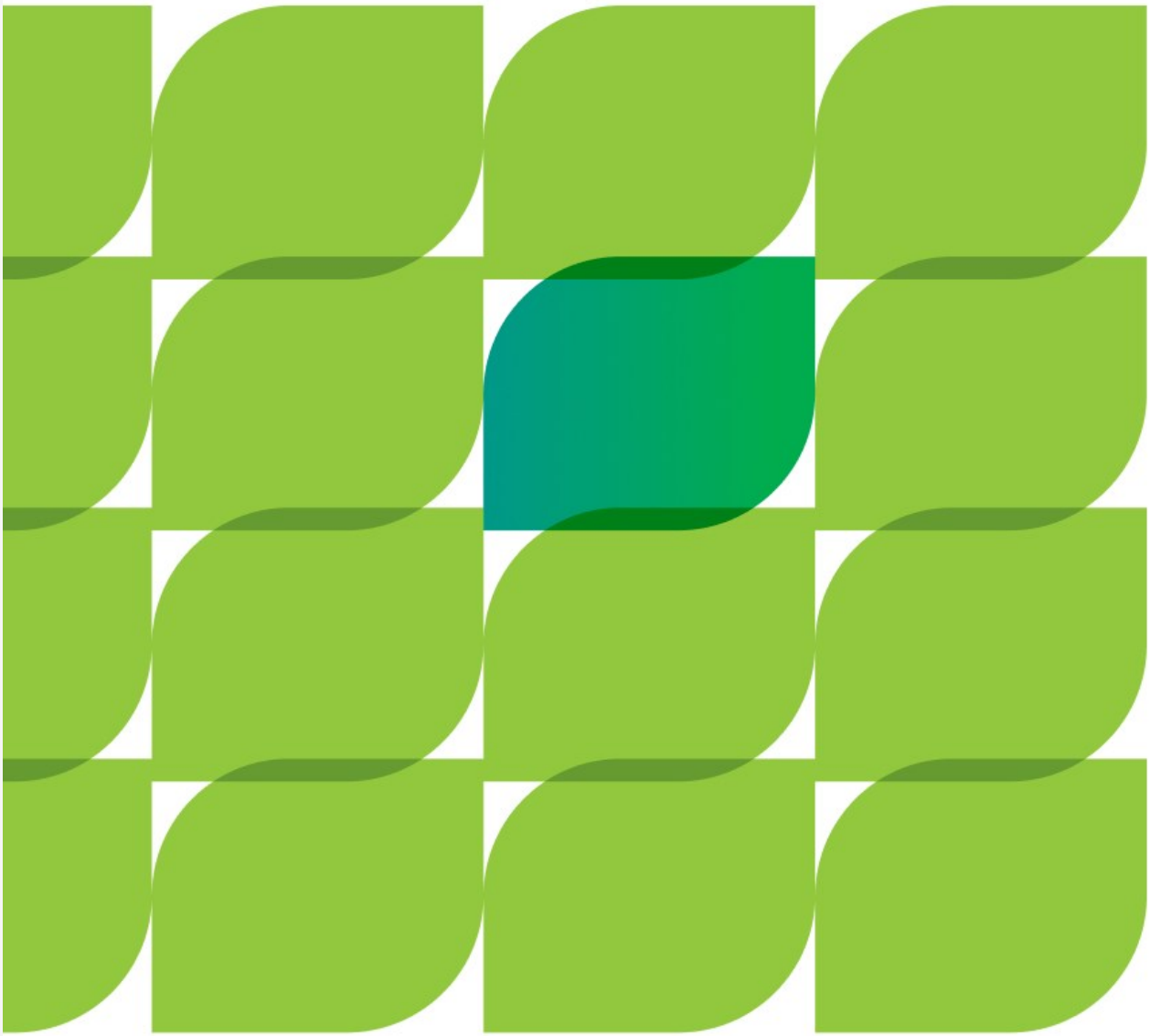
Digital 4 Sustainability
Skills for Europe's Twin Transition

Annexes

To D2.1 Roles and Skills needs analysis report



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D2.1.Annex.A Digital for sustainability role profiles

1.1 Role profiles

Role profiles are a generic set of roles performed by professionals. They describe a certain role at a relatively high abstraction level, clustering typical and common job role components into a consistent format. Jobs or functions are normally described in a much more detailed way, specific to an individual and the organisation. They contain personalised and more specific information such as terms and conditions of employment, remuneration or specific tools. A person working in a certain job can fulfil multiple roles depending on the tasks this person has.

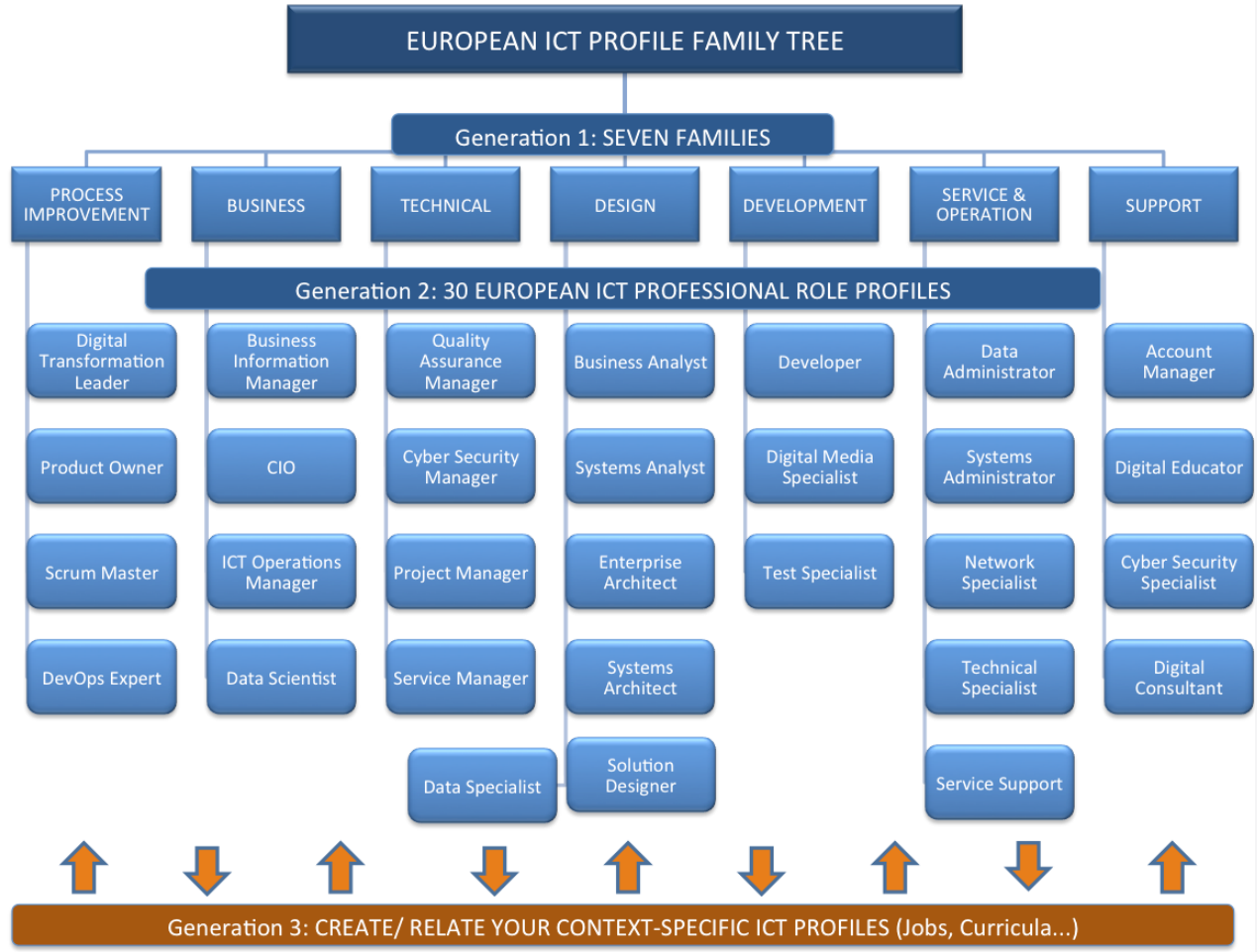
1.1.1 CEN ICT Professional Role Profiles

In the field of ICT, the European standardisations organisation CEN has published a set of European ICT Professional Role Profiles[1]. They were developed in a European context, involving a large number of different stakeholders. As such, they provide a common reference language and communication tool to support mutual understanding e.g. both between countries and stakeholders but also within organisations. These set of profiles are not intended to represent a rigid standard, but were built as a foundation and inspiration for the flexible creation of more context-specific profiles in a broad variety of areas. The role profiles relate closely to the European e-Competence Framework (e-CF)[2], as they incorporate the competences of this framework.

There are 30 role profiles, structured in seven main profile families. In the framework, the profile families are called 'generation 1' and the role profiles are called 'generation 2'. The profile descriptions are reduced to their core characteristics which clearly differentiate them one from

[1] CEN Workshop Agreement (CWA 16458-1:2018) – European ICT Professional Role Profiles version 2 – Part 1 Full descriptions.
[2] CEN/ TC428 (EN 16234-1:2019) - e-Competence Framework (e-CF) - A common European Framework for ICT Professionals in all sectors - Part 1: Framework

another. Users can create their own so-called 'generation 3' profiles by adapting the role profiles to their specific environments and needs[3].



Figuur 1 European ICT Professional Role Profiles (CEN CWA 16458-1:2018)

1.1.2 Digital Sustainability role profiles

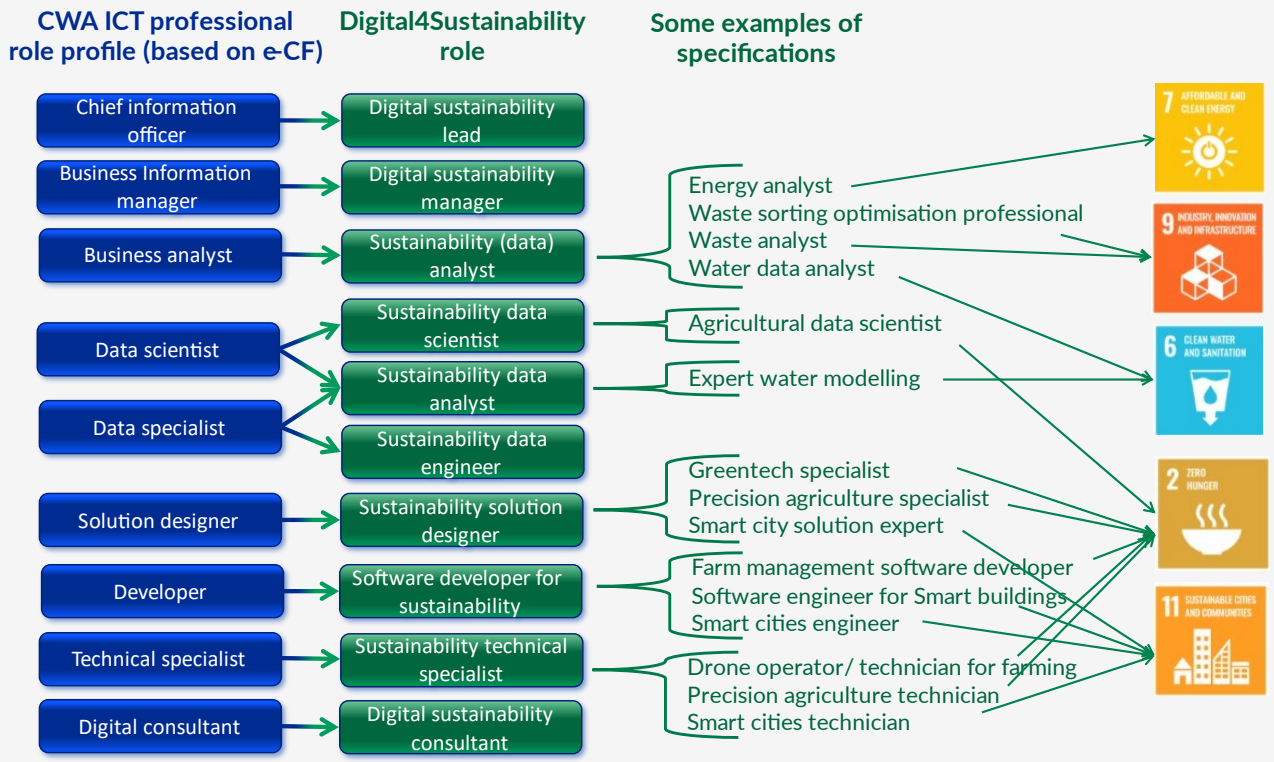
Based on initial research, 9 role profiles were selected from the set of 30 European ICT Professional Role Profiles that could be recognised in the context of digital for sustainability. This resulted in 10 digital sustainability role profiles, that could be grouped into 3 main areas:

- **Management & consultancy**: Digital sustainability lead, digital sustainability manager, digital sustainability consultant.

[3] CEN Workshop Agreement (CWA 16458-2:2018) – European ICT Professional Role Profiles version 2 – Part 2 User guides.

- **Data processing & analysis**: Sustainability business analyst, sustainability data scientist, sustainability data analyst, sustainability data engineer.
- **Development & operations**: sustainability solution designer, software developer for sustainability, sustainability technical specialist.

These 10 digital sustainability role profiles are the translation of the ICT Professional Role Profiles to the field of sustainability. In terms of the ICT Professional Role Profiles report: These are 'generation 3' role profiles for digital sustainability. It is quite easy to find specific examples of these roles when looking at job vacancies in this area. Usually these are related to specific sectors (e.g. agriculture, energy) or fields of application (e.g. smart cities). These specific roles support the different sustainable development goals[4], each in their own way.



Figuur 2 Digital Sustainability Role Profiles, examples and links to SDGs

[4] United Nations - Department of Economic and Social Affairs. Sustainable Development: The 17 Goals. *Accessed 23-10-2024*: https://sdgs.un.org/goals

1.2 Description of roles

1 MANAGEMENT & CONSULTANCY

1a Digital Sustainability Lead

Defines and implements a digital sustainability strategy, policy, and governance across the organisation. Provides leadership for the implementation and development of sustainability by the organisation's architecture and applications.

Alternative names: ICT/ IT Sustainability Lead, Digital Sustainability General Manager, ICT/ IT Sustainability General Manager

1b Digital Sustainability Manager

Proposes, plans and manages the functional development of the information system, focusing upon sustainability. Ensures the continuous enhancement of sustainability by ICT.

Alternative name: ICT/IT Sustainability Manager

1c Digital Sustainability Consultant

Advises organisations on their digital sustainability strategy and its implementation of applying digital technologies to reach sustainability goals and add value to a business in the most effective and efficient manner.

Alternative names: Digital Sustainability Advisor, ICT/ IT Sustainability Advisor, ICT/ IT Sustainability Consultant, ICT/IT sustainability systems consultant

2 DATA PROCESSING & ANALYSIS

2a Sustainability Business Analyst

Analyses an organisation's processes and systems and optimises business performance with regard to sustainability through technology application. Provides possible ICT solutions compliant with the digital sustainability strategy.

Alternative names: ICT/ IT Business Analyst Sustainability, Business Analyst Sustainability

2b Sustainability Data Scientist

Delivers insights from data by optimising the analytics process focusing on sustainability. Creates, identifies, selects and optimises the mathematical models, the algorithms and predictive models to deliver insights in sustainability aspects, applying advanced programming techniques.

2c Sustainability Data Analyst

Imports, inspects, cleans, transforms, validates, models and analyses collections of data with regard to sustainability. Ensures that the data sources and repositories provide consistent and reliable data. Prepares sustainability dashboards and management reports.

2d Sustainability Data Engineer

Builds and maintains systems that collect, manage, and convert raw data into usable information regarding sustainability for data scientists and analysts to interpret.

3 DEVELOPMENT & OPERATIONS

3a Sustainability Solution Designer

Proposes and designs solutions that support sustainability in line with technical architecture which fit business requirements and support change.

3b Software Developer for Sustainability

Designs and/ or codes components to meet sustainability specifications. Builds and implements ICT applications and components that support sustainability.

Alternative name: Software Engineer in Sustainability

3c Sustainability Technical Specialist

Installs, maintains and repairs hardware, software and service applications that support sustainability. *Alternative name: Digital Sustainability Technician*

Figuur 3 Short descriptions digital for sustainability role profiles

1.3 References

- CEN - European Committee for Standardization (2018). Workshop Agreement - CWA 16458-1. *European ICT professionals role profiles - Part 1: 30 ICT profiles.* Brussels: CEN-CENELEC. *Available at* : https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN%20sectors/Digital%20Society/CWA%20Download%20Area/ICT_SkillsWS/16458-1.pdf

- CEN - European Committee for Standardization (2018). Workshop Agreement - CWA 16458-2. *European ICT professionals role profiles - Part 2: User guides.* Brussels: CEN-CENELEC. *Available at*: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN%20sectors/Digital%20Society/CWA%20Download%20Area/ICT_SkillsWS/16458-2.pdf

- CEN - European Committee for Standardization/TC 428 (2019). European norm EN 16234-1. *e-Competence Framework (e-CF) – A common European Framework for ICT Professionals in all sectors - Part 1: Framework.* Brussels: CEN-CENELEC. https://standards.cencenelec.eu/dyn/www/f?p=205:110:0::::FSP_PROJECT:67073&cs=15E62ED24D608A5F10D6BEE8E6D50FA10

- United Nations - Department of Economic and Social Affairs. (n.d.). *Sustainable Development: The 17 Goals*. *Accessed 23-10-2024*: https://sdgs.un.org/goals

D2.1.Annex.B Literature review

2.1 Purpose and approach

As part of the Needs Analysis (WP2), the academic literature is reviewed to assess the state of the art and distill starting points for the development of the skills strategy. The focus was broad and multidisciplinary, with seeking articles that discuss the following topics (in isolation or in combination):

(i) the twin transition and the way it develops (for which a range of alternative search terms were used as twin transformation, dual transformation, digitainability, sustainable development and digitalization, green jobs and technology);
(ii) a focus on skills, competences, abilities or capabilities, both on an individual and organizational level in relation to the twin transition;
(iii) the job market in relation to the twin transition;
(iv) education in relation to the twin transition.

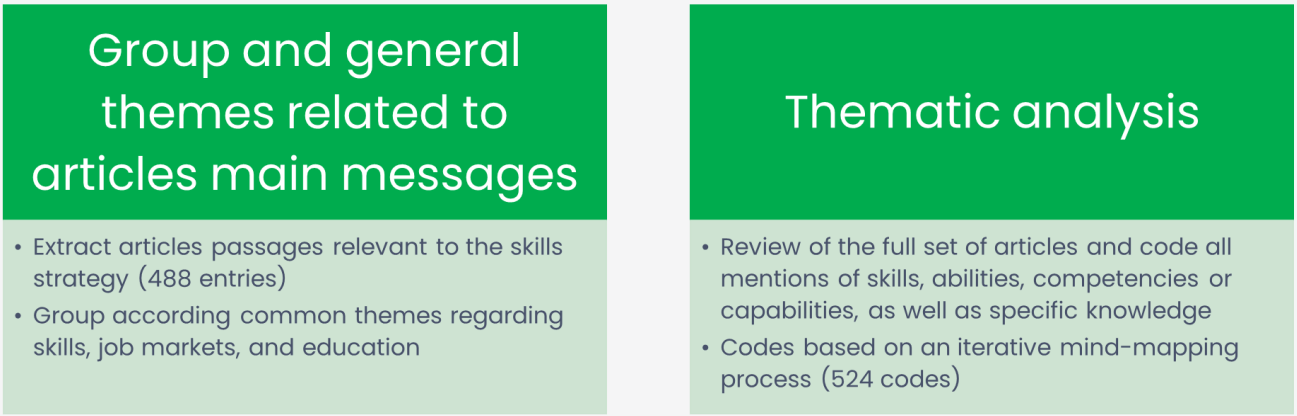
All academic partners added to a shared database, which helped to prevent regional and disciplinary biases. Articles came from the members' databases and networks, were found through Google Scholar, and through snowballing with tools like 'Research Rabbit'.

In terms of quality of the sources the preference was to include peer reviewed articles, (academic) book chapters, and PhD-theses only. However, due to the nascency of the field, it was deemed essential to include conference proceedings in the scope. As a measure of quality, we did solely include those conference papers that have a permanent digital identifier like DOI, ISBN or arXiv.

The final database consisted of 70 articles, covering a wide range of sectors and countries. The oldest article was written in 2019, with the majority being published in 2023 or 2024. An overview can be found in Appendix A. In addition, 6 articles have been included in the review, which share frameworks on either sustainability [1–5] or digital skills [6]. As the separate fields have evolved further than the literature on skills for twin transition (or digital sustainability skills), these frameworks have been used as reference materials during the analysis of the 70 core articles.

The analysis of the database was conducted in two different, complementary ways (see figure 1).

Figure 1 – Two steps approach of the analysis



Firstly, (i) all articles have been read in full and any passages that could be relevant to the skills strategy have been copied to an Excel file. The file consisted of 488 entries. As a next step, the main messages were grouped together, to distill common themes in the literature regarding skills, job markets, and education. These themes will be described in section 3.

Secondly, (ii) a thematic analysis was conducted by reviewing the full set of articles to code all mentions of skills, abilities, competencies or capabilities, as well as specific knowledge that was necessary. In coding only those pieces of text that were based on original empirical or conceptual work were included (which means not part of a general introduction or literature review section). This limitation resulted in only 42 articles providing input for the thematic analysis. In the table in Appendix A it is indicated which articles this concerned. For each specific piece of information on skills or knowledge that was based on original work a quote was recorded in an Excel spreadsheet. A code was attached to capture the focus of the quote, staying close to the original wording. Where possible several quotes were merged into a similar quote, but only when this did not illude the specificity of each of the codes. A total number 524 codes were developed in this process. And for each code, the region, sector, and unit of analysis were noted in the Excel file.

Next, a process of categorizing started. The original codes were grouped and organized in an iterative process. To make sense of the data, multiple hierarchical layers were created to catch different levels of abstraction. A data structure of 6 levels was established, with level 1 referring to the basic code 2 resulting in hierarchical layers. During this process, six levels of abstraction were established, with level 1 representing the original codes representing the specific quotes, and level 6 being the highest level group of 'twin transformation competences' capturing all the codes together.

To smoothen the analysis process of the large dataset, first a subset of 18 random articles has been analyzed through the process described above. In developing the codes and different hierarchical levels and naming them, the 6 articles addressing either sustainability or digital skills were used as reference. As a next step, the remaining articles were coded with the preliminary coding scheme, while finetuning and adding onto the scheme when necessary.

The initial plan was to, as a last step of the thematic analysis, compare the results on the different units of analysis, region, and sector. However, considering a skewed distribution of codes of the different categories and specification information lacking in part of the articles, this comparison was not feasible with the current dataset. Also, given the variety of the contexts and roles the articles focus on, counting the different mentions of specific skills was not meaningful. The result of the analysis is hence a mapping of all the twin transition skills as mentioned in the reviewed database resulting from earlier research. This overview is discussed in section 4 of this document. Although no conclusions can be drawn on which skills are relevant for which role, or in which sector, the clusters that resulted from the analysis can be used for input for the skill strategy and evaluating existing job profiles.

This report ends with a conclusion (section 5) in which the main take-aways of the analysis for the skill strategy are formulated.

2.2 Definitions

Before moving to the results of the two-step analysis introduced above, key definitions as used in the reviewed literature are discussed. The focus is firstly on the term 'twin transition' and all variations, and secondly on the context of sustainability. A full overview of the terminology and definitions in the literature is provided in Annex B.

The term 'twin transition' was introduced in 2020 by the European Commission with a strategy to aimed at supporting the simultaneous to a green digital economy[5], and 25 of the reviewed articles uses this term [7–31]. Many of these article indeed refer back to the European Commission when defining the concept, with the most extensive example being of Aagaard and Vanhaverbeke[7] :

> Accordingly, and in response to the urgent need for sustainable development, the European Commission has championed the concept of twin transition (TT) or digitally enabled sustainable transition, emphasizing the role of digital technologies in driving eco-

[5] European industrial strategy - European Commission (europa.eu)

> friendly transformations, while emphasizes the integral connection between sustainability and digital transitions, viewing them as co-dependent elements critical for future progress (European Commission, 2024a). (p. 228)

In some cases specific contextual focuses are added, like a specific focus on the energy sector[13], offsetting companies' carbon footprint [16], or a 'net-zero carbon and resilient built environment[22].

Besides twin transition, alternative terms are found in the literature, being twin transformation[32,33], dual transformation[34], digitainability[35], sustainable digital transformation[36,37], digital sustainability[38–40], green digital transformation[18] and twin transformation[41,42]. The alternative terms are not in all cases defined, but when definitions are provided, the emphasis seems to lie more strongly on organizational transformational processes. Christmann et al. [33] for instance define the twin transformation as: "a value-adding interplay between digital and sustainability transformation efforts that improve an organization by leveraging digital technologies for enabling sustainability and leveraging sustainability for guiding digital progress" (p. 7).

In all other cases no key term was applied, but rather combinations of terms like 'digital transformation' and 'sustainability' were used.

Next, definitions of the term sustainability were assessed. Only in 27 of the 76 articles in the database some sort of definition of sustainability is provided, while some discuss specifically the diffuse use of the terminology[43,44]. By many the 3 dimensions of 'the triple bottom line'[45] are acknowledged, being social, environmental and economic[7,12,14,17,22,25,32,33,36–38,40,41,44,46–55], whilst many solely focus on the green dimension[8–11,15,16,18,20,21,23,26,31,39,42,56–64]. This can be explained by the domain of application in the study, for instance with a specific focus on circular economy[42,57,58].

Only a few of the articles delve deeper into the meaning of sustainability, for instance going back to the origins of the concept, for instance referring to definition of sustainable development of the United Nations, which focuses on the ability of future generations to meet their needs[65]. An example comes from Pospelova et al.[66]:

> Sustainability is a paradigm for thinking about a future in which environmental, societal, and economic considerations are balanced in the pursuit of an improved quality of life: "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (p. 1).

And George and Schillebeeckx[38] call for a connection to the regeneration paradigm as:

> Through regeneration, the focus of corporate sustainability expands beyond reducing negative externalities of resource use – the dominant sustainability paradigm in the extractive economy - towards the explicit inclusion of and accounting for positive impact – the paradigm of the regenerative economy. (p. 4)

2.3 General trends in the literature

In this section general trends in the reviewed articles (step 1 of the analysis) are discussed. Consecutively the following topics are addressed: the twin transition in general and how it develops, the job market and the issue of skills shortage, the need for education and training, the different roles in the transition, and lastly the importance of taking into account heterogeneity in multiple respects.

2.3.1 Twin transition

Not surprisingly, given the selection of articles, hope for technology bringing innovative solutions to move towards sustainability is widespread[21,23,31,60,67–70], and some articles demonstrate positive impacts of digitalization on sustainable corporate development[55] or sustainable competitiveness [12,26].

Also, it becomes clear from the reviewed articles that the twin transition should be considered as a fundamental change[7,41,57], asking an institutional paradigm shift[7,19]. As such, the twin transition implies change within organization on many different levels. The literature mentions the need for new or changed business models[7,14,30,36,44,47,57,67,68], operational processes[47,71], supply chains[60], leadership style[7,57], organizational structure[7,49,71], risk management[68], governance[49,55], reporting structure[49], organizational culture[7,57,72], knowledge management[57,72], and technological management[18], which includes the availability of precise data[14].

And, another important point of attention, is that organizations should move towards working in ecosystems, requiring altered ways of relating and working with stakeholders[7,57,68].

Given the fundamental transformation needed on all these aspects, it is also concluded that the twin transition is still in an early stage[23], investments are limited[57], many companies are still ill prepared[68], with only few companies succeeding and in many other cases companies opting for

non-invasive solution adoption only[42]. The twin transitions starts with awareness[49], and more awareness is needed. This concerns: sustainability issues[4,39,57,73], megatrends and global drivers[4], and opportunities digital technologies can bring for sustainability[16,23,28,43]. For the latter it is indicated that the number of concrete use cases[22] and business models[30] needed for inspiration are still limited, and needs to grow. This is even more so when it comes to SMEs, as the transformation is especially difficult for this group of companies[25].

2.3.2 Job market and skills shortage

Considering the paradigm shift associated with the twin transition, the job market is also expected to be greatly impacted. With a changing focus from Industry 4.0 to Industry 5.0, the fear of humans being replaced by technology is reduced. Instead, the expectation is that the focus will be on the interaction between people and technology[15,54], with jobs that do not need creativity being abolished[15,54,61,71]. This means that there will be both job loss and creation of new jobs[12,46,53,54,68,71].

The expectation is that there will be mainly a need for more highly educated workers[15,55]. This is due to the fact that for the new jobs a wider variety of skills is necessary[72], and an analysis of job vacancies for green AI jobs indicated that the number of skills requested is larger than green jobs or AI jobs[15]. Due to the more complex nature of new jobs, there are hopes that they can lead to higher wages and better wellbeing[39]. On the other hand, it can lead to structural unemployment, especially in countries that now have many low skilled workers[54,71]. Therefore, it is important to help low-skilled workers by for instance developing easy-to-use technological tools[54]. Also, it is indicated that due to the quickly evolving digital technologies, there will be a need for lifelong learning in order to stay competitive in the labor market[54].

Another consequence of the developments sketched above, is that a skill mismatch is to be expected[15,39,46,54,60,68,72].

Skill shortage is already mentioned as one of the main barriers for the twin transition[25,28,39,40,42,54,57,60,63,66–68,70–73] And as the other side of the same coin, having the right human capital is considered as an important competitive advantage for companies[27,35,40,46,53,55,57,60]

Different skills shortages are specifically mentioned in the literature: the ability to translate IT knowledge to IT business opportunities[72], IT workers with both excellent technical skills and sustainability knowledge[72], workers with knowledge about CE and how to integrate into daily

operations[42], people with combined IT and CE knowledge[57], programmers who can deliver energy-efficient code[72], skills for effective waste management through digitalization[67], workers to form teams with the capability to support IoT implementation[66], change management capabilities[60], analytical capacity[57], the ability to measure impact of IT on sustainability[72], and skills for data handling and analysis[51].

As solution companies move to skill-based hiring instead of hiring based on diplomas solely[15,24,51,72]. Another option is hiring external expertise, although the lack of consultants is also indicated as a barrier for the twin transition[25].

Training and education

It is clear from the above that there is a need for large skill re- and upskilling[7,11,21,52,60,63,68,69,73]. Moving forward with the twin transition requires fundamental changes in higher education to prepare the future workforce[4,15,39,43,48,51,52,54,71,73–75]. Teaching must move to multidisciplinarity[4,43,74], and address topics like IT and sustainability[34,43,72]. Specifically the integration of technology and sustainability should be addressed[48], whilst addressing both the threats and opportunities IT brings for sustainability[43,72]. Teaching should involve best practices[34] and real cases[73]. Other issues to address in curricula mentioned in the literature are: technological skills[72], optimal resource use[43], ethics[43,72], legislation[72], circular principles[16], and personality development[75].

It is further suggested that technologies also need to be applied in education[16] for better preparation and reaching larger groups of people. Examples provided in the literature are game-based learning to cater divers social contexts[76], or a platform for training of engineering students[74].

At the same time, it is noted that the current skill gap cannot be addressed by institutions for higher education alone. Firstly, changing curricula does not reach the current workforce[50]. Secondly, as noted by Hazrat et al[74], education is not able to adapt quickly enough to the fast technological changes; he posits that we currently find ourselves in a 'social pain phase', which he compares to the early stages of the industrial revolution. On top of that Hofmann Trevisan et al.[16] indicate that the current transformation requires changes in education starting at the primary school level..

This means that companies need to act in order to fill a gap[15] and invest in training[27,51,68,72]. Examples of such training mentioned in the literature are: in-house training[40,57,72,73], on-the-job training, MOOCs, apprenticeship, bootcamps[15], mentorship[72,73], job shadowing, coaching, and role

models[73]. At the same time ,it is indicated that companies need to invest in life-long learning[50,51,54,75], and cultures that enable that[27,68,77].

A challenging aspect is that companies first need to be able to assess the skills they need[57,77] and have in-house but often are aware of neither of those two[72]. This also makes it difficult for companies to signal their needs to policy makers, a capability deemed important by Maliphol and Walter[39]. This calls for a cooperative effort between different actors to address the skill gap[11], including cooperation between companies and universities[4,57,72,75].

As mentioned above, it is noted that the twin transition increases both the number and variety of skills needed by organizations. In the next section of this document, an extensive overview of all the twin transition skills that are mentioned in the literature is provided. On a general note, it is not only mentioned that skills need to be combined[39,54,69], which asks for a set of integral competences[75], but also that synergy between skills needs to be created[16]. Based on this reasoning, twin transition skills are more than just an adding up of different skills, although it is noted that companies need to build on top of existing capabilities[42], and already existing skills need to be applied in a different way or context[39]. The skill set needed can differ per sector and company[72], although there seems to be a set of digital and soft skills that are transversal[51]. For instance, it is noted that a lack of social competences can limit the career opportunities of technical workers[51,54].

Lastly, attention is placed in the literature on the role of consumers in the twin transition, which holds that a basic level of digital skills of the general public is needed as they need to uptake new tools[13].

Roles

The focus in the reviewed literature is on adding skills to existing job profiles, over defining new digital sustainability roles. Although e.g., Teichmann et al.[78] do make a distinction between general workforce skills and specialist, this distinction is not further specified. By others it is stated that general IT-staff does not need sustainability knowledge[72], and only some general professional ethics and security[75]; the same holds for technicians that are focused on daily operations[66]. On the other hand, more specialist functions require more knowledge and skills. Examples mentioned in literature are security experts and technicians specialized in digital infrastructures[54], engineers that need more additional skills and knowledge[75], developers that have to act as business advisors[72], and the deep emphasis on group work in the software engineering industry[75].

In general, ample attention in the literature is given to the roles of: entrepreneurship[11,26,39,55,64], innovation[42,53,55], and leadership[7,36,46,49,55,77].

Top management plays a crucial role as a leading organizational change agent[55]. In order to be able to take that role, leadership itself needs to transform[7,36,46,77]. As mentioned before, this starts with awareness[49,64], followed by commitment to change with 'appropriate urgency and seriousness'[49,57,60], and a willingness to make bold and big decisions[44]. In terms of abilities, this needs: strategic foresight[7], the ability to navigate complexity[7,42,44,48], systems-thinking skills[37,48], the recognition of long-term value derived from integrating digital transformation and sustainability transformation[7,34,37,46,55,69], creating a shared vision for the twin transition[34,55], to develop integrated strategies for the twin transition[26,37,48,55], including priorities[42], and constantly update them[44].

In terms of innovation and finding uses cases, it is indicated that tech-leaders should take the lead by sharing knowledge on technological development and opportunities[46], and also service businesses[22], or technology solution providers[25] are needed for developing smart solutions and act as innovator-promotor[22]. This is needed to actually engage with the twin transition, based on an awareness of the opportunities. And in turn the MNEs, are expected to lead smaller companies[28,38] in a similar way.

The role of senior management is also addressed in terms of managerial activities[26] for implementation with need for a dedicated (C-level) person to guide the transformation[49]. The twin transition strategy has to be translated into a change program which needs to be managed [26,34,37,49,69]. The change program should be focused on (i) moving towards a culture of adaptability, openness and continuous learning[7], and of innovation and CSR[34], which allows the deployment of digital for sustainability to succeed[46]; (ii) to enhance digital literacy[7,34,69], and sustainability awareness[7] in the organization; (iii) to develop new corporate governance practices[37]; and (iv) to cultivate relationships with other parties[7,34], for instance focused on supply chain integration and coordination[53].

Other roles addressed in the literature are HRM departments that need to embed training and education[39,40], and marketing to bridge the gap to customers[18], change attitudes and fear of customers on e.g., IoT[66], or act as digital marketing specialists[54].

Also, policymakers play crucial roles[54,67], for instance in establishing investments[20,23]. Policymakers also need to take up an entrepreneurial role [11], while it is acknowledged that the EU is active in this field[16,21,22].

2.3.3 Cooperation

Another important trend in the literature is the focus on cooperation between partners, based on a move to 'ecosystem thinking'[37,49,68]. This translates to the emphasis on (ecosystem) cooperation skills. Three reasons can be distilled on why more intense external cooperation is needed. Firstly (i), the twin transition requires a systemic shift of interdependent actors[11,46]. The transformation involves a redesign of supply chains or value chains[25,30,42,53,57,60,71]. It was already discussed above that education needs to transform as part of the twin transition, which means that education[54,61] and research institutes[11,25,42,54,61] have roles to play. Also, customers are involved[25,39,42,60,68] for the adoption of smart tools[13]. Civilians need to be taken along for public opinion and as part of the (future) workforce [11]. Governments have roles to play[54,57] for (local) policy and infrastructures[13,39]. Lastly the importance of involvement of local partners as trade unions for local uptake[11], and standardization institutes[25] are mentioned.

A second reason (ii) for the focus on cooperation is that for most companies it is impossible to have all capabilities and resources in-house[39,42], so they need to outsource[47], or collaborate[72] on new value creation models[25,49,68,69]. And lastly (iii) data play a crucial role in the twin transition. There is a need for data-sharing[57,69,71], and the establishment of shared standards[49,57,68].

2.3.4 Mind the differences

A final point to make regards heterogeneity that needs to be taken into account in multiple aspects in understanding of and intervening in the twin transition. Some authors point to (i) regional differences within Europe[10,23], and globally[23], e.g., in terms of current digital literacy and awareness[23] in general and of the workforce[54,63] and customers[13] in particular. Also, the existing digital infrastructure[39,57], average level of employment[54], and preferences of and interactions between local actors[11] vary per region. And lastly, the current integration of digital and sustainable in educational programs[51], and digital literacy of students and teachers[52] are heterogeneous.

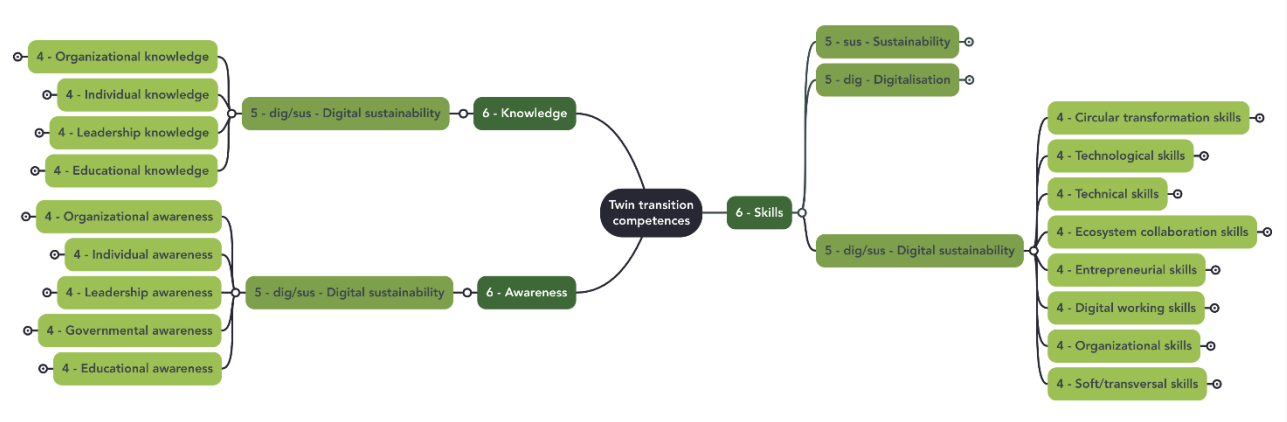
Other dimensions of variation to take into account are (ii) the starting point of the organization in the transformation in terms of maturity level or existing dynamic capabilities[32]; (iii) the state of development of the industry and associated needs[13,21,57]; (iv) company size[20], and the specific tools used[10].

2.4 Thematic analysis

This section shares the results of the thematic analysis of skills, abilities, competences, and capabilities as mentioned in the reviewed literature. As elaborated in section 1 a data structure of 6 hierarchical levels has been developed (with level 1 being the original codes, and level 6 being the overall category of 'twin transition competences'). The data structure will be discussed stepwise. The references are included to indicate the source(s) on from which the code is retracted. The level 1 codes are not included in the pictures below.

As a first step in the analysis, the overarching level of the coding scheme (level 6) has been labelled 'twin transition competences', incorporating **'skills'**, **'knowledge'**, and **'awareness'** under the broader category of 'competences'. A competence can be understood as the ability to apply knowledge, skills, and social and/or methodological abilities in work or study contexts, as well as in professional and personal development[79].

Figure 2 -Overview of Twin Transition Competences Knowledge, Awareness and Skills

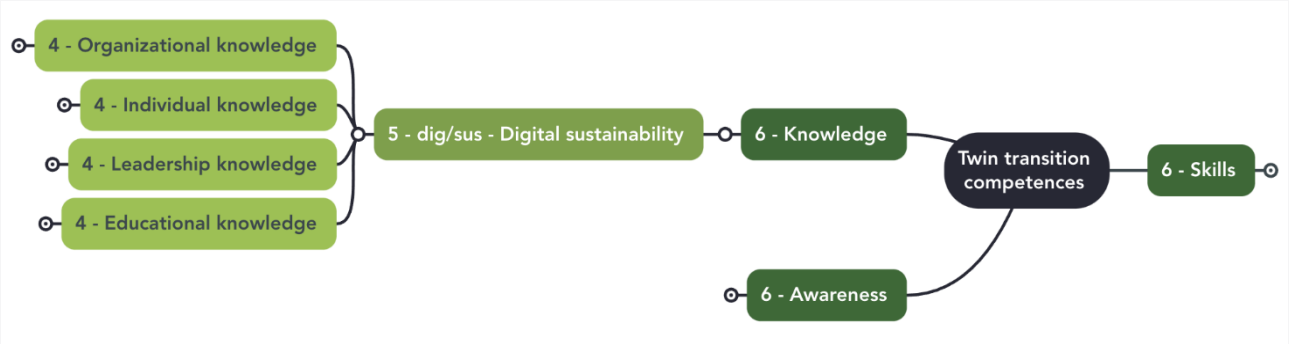


Knowledge refers to the theoretical or practical understanding and awareness of phenomena such as facts, terminology, concepts, models, or theories that are related to a field of work or study[80]. **Skills** refers the ability to apply knowledge and use know-how to complete tasks and solve problems[80]. And for **awareness** the definition of Raymundo et al.[81] of sustainability awareness is used as a frame of reference: "an understanding of the fragility of the environment and the importance of its protection, thinking in terms of an ecological consciousness" (p.1). In the context of twin transition competences this kind of awareness includes an understanding of how digital technologies can help in this protection. Furthermore, the awareness in the context of this review

includes social/dimensions of sustainability. Bringing this together, would result in a definition as: 'an understanding of the fragility of social and environmental systems, the importance of protecting and enhancing those, combined with an understanding of the way that digital technologies can help in this protection and enhancement'.

The focus in the thematic analysis has been on the twin transition, or digital sustainability skills, or on the mentioning of skills on the intersection between the digital and sustainability transition. In some articles specific skills for either digital or sustainable transition were mentioned; these are included in the data structure separately. Therefore, Figure 2 includes sustainability and digitalization skills, which were used solely as reference points in the coding process and will not be addressed further in this review.

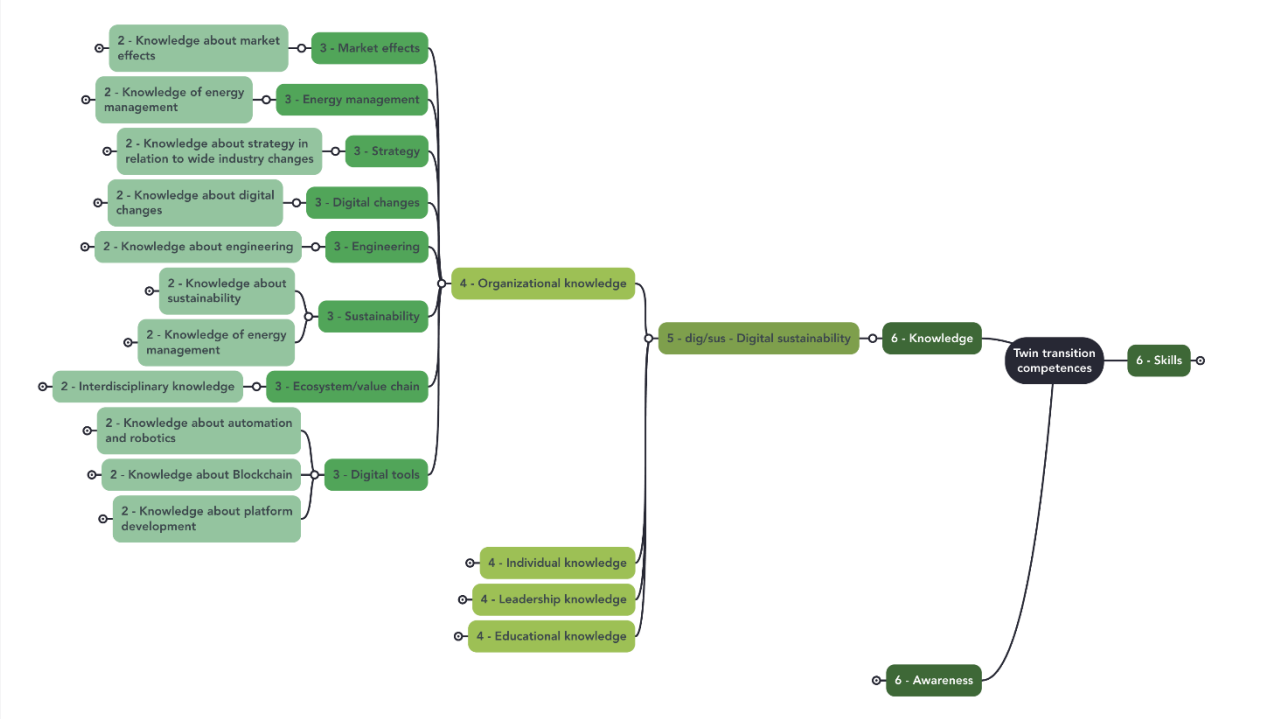
Figure 3 -*Overview of Knowledge*



2.4.1 Knowledge

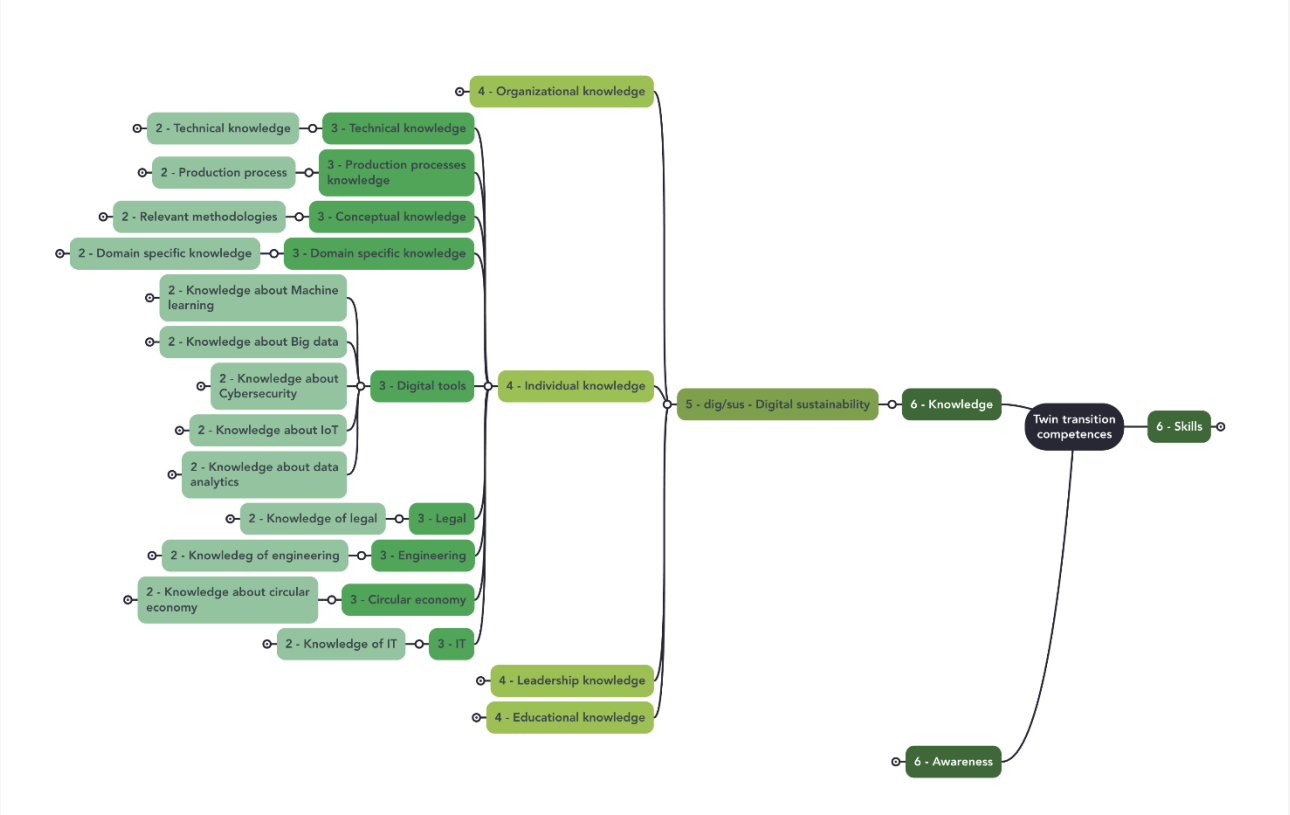
The first category to be discussed, is that of knowledge. To impose a structure missing from the literature, different levels were identified through by considering the unit of analysis related to the specific codes.

Figure 4 -*Overview of Organizational Knowledge*



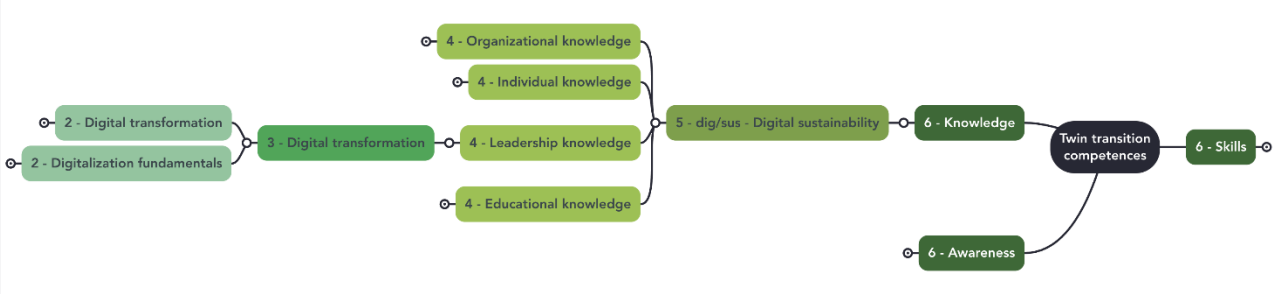
Starting with **organizational knowledge**, the analysis distilled eight different types of knowledge on an organizational level from the literature, being: knowledge about market effects[32,36], knowledge of energy management[57], knowledge about strategy in relation to wide industry changes[36], knowledge about digital changes[36], knowledge of engineering[25], knowledge about sustainability[39,57], knowledge about ecosystems and value chains[51] and knowledge about digital tools[36,57,60].

Figure 5 -*Overview of Individual Knowledge*



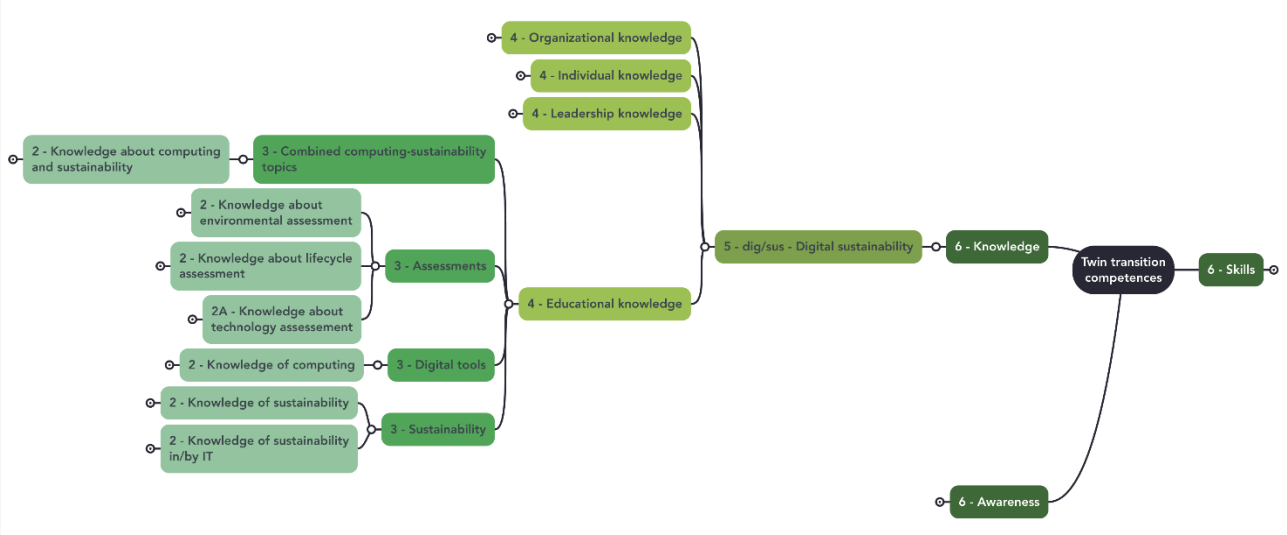
The analysis identified nine distinct types of knowledge at the individual employee level. In some instances, this refers to an organization's staff in general, while in others it pertains to specific roles, such as engineers or technicians. However, due to the limited literature available to establish a strong foundation of skills for certain roles, these skills have all been categorized under the label '**individual knowledge**', namely technical or production processes knowledge, conceptual and domain specific knowledge and legal, IT and engineering knowledge[62]. Furthermore, knowledge of digital tools such as robotics and Blockchain are identified[66], just as circular economy knowledge[42] .

Figure 6 - *Overview of Leadership Knowledge*



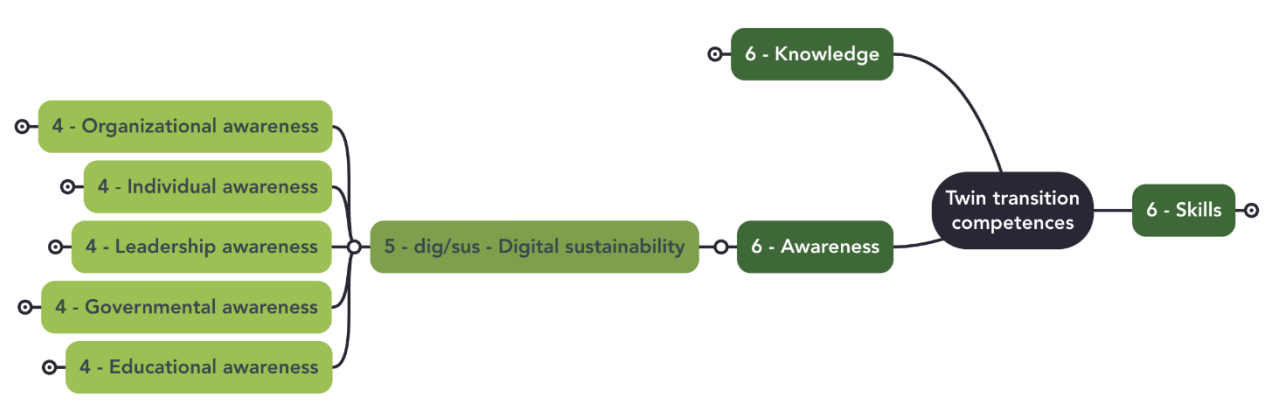
The next type distilled is **knowledge for leadership** and concerns the fundamentals and general knowledge of digital transformation for top- and senior management[43].

Figure 7 - *Overview of Educational Knowledge*



Educational knowledge discusses which knowledge should be implemented in learning programs as part of education transformation in light of the twin transition and is divided into the following four domains: combined computing-sustainability knowledge, technology assessment, digital tools and sustainability[43]. Clearly, this must represent only a preliminary insight into a much broader and complex set of knowledge aspects.

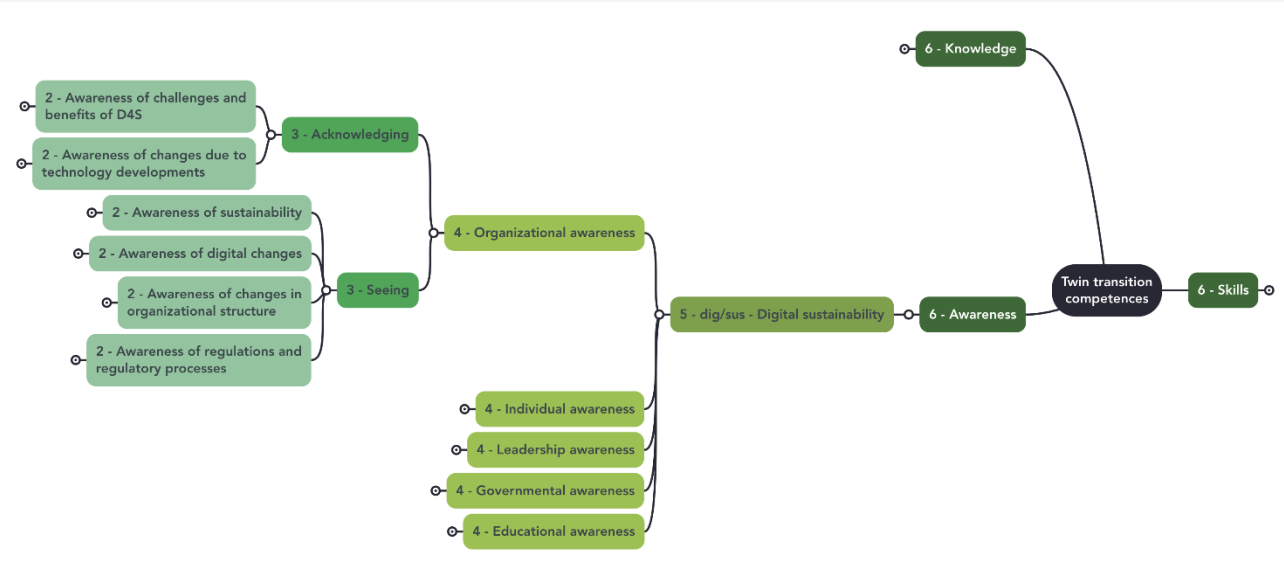
Figure 8 – *Overview of Awareness*



2.4.2 Awareness

The second category to be discussed, is that of awareness. Similar to the approach for knowledge, different levels were identified based on the unit of analysis to build the data structure in this thematic analysis

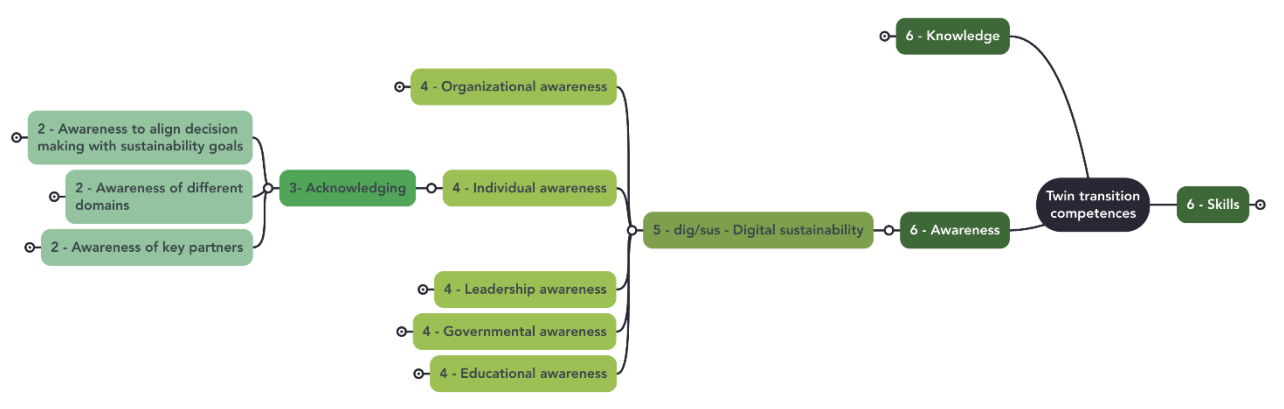
Figure 9 – *Overview of Organizational Awareness*



Organizational awareness (acknowledging) consists of understanding challenges and benefits of digital for sustainability[33] and awareness of changes due to technology developments[36,46].

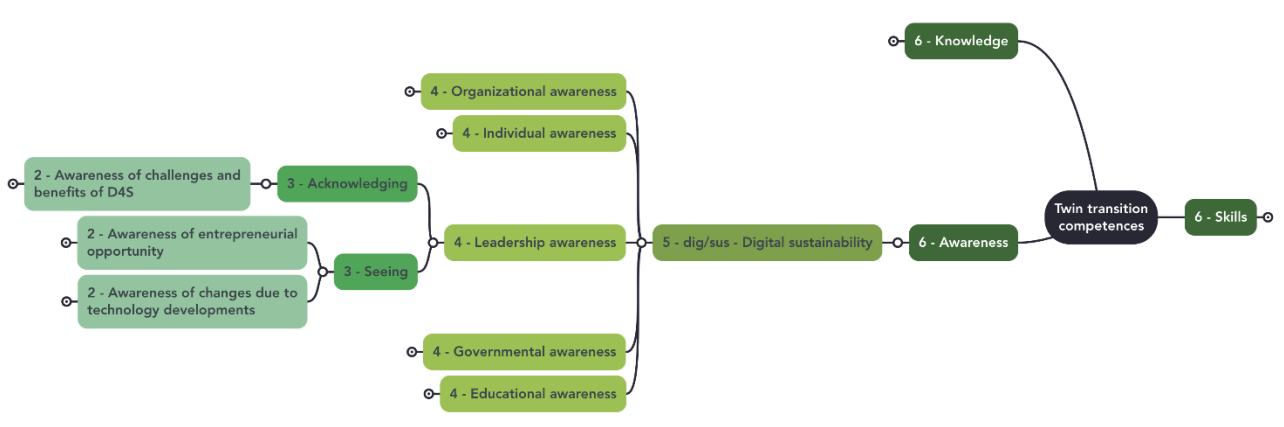
Organizational awareness (seeing) is made up of awareness of sustainability[39], digital changes and changes in organizational structure[36], and regulations and regulatory processes[57].

Figure 50 - *Overview of Individual Awareness*



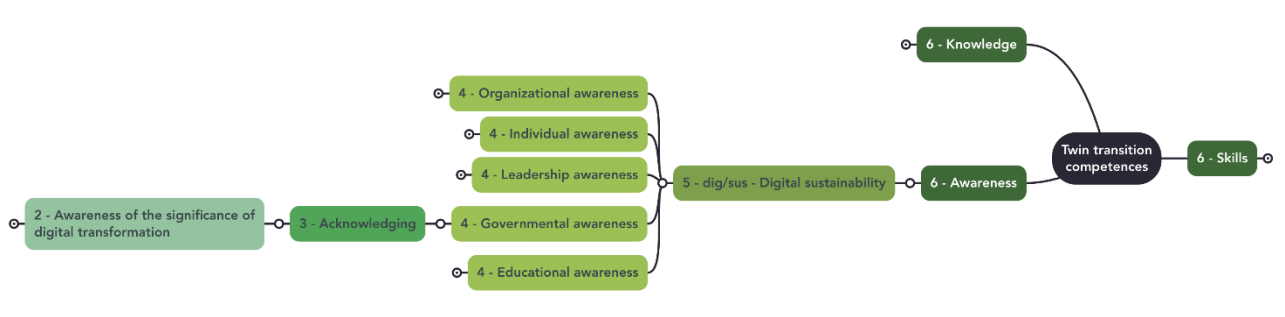
Individual awareness (acknowledging) consists of awareness of aligning decision making with sustainability goals[49], recognizing different domains and enabling key partners for assessing ideas[62]. There are no **seeing** elements mentioned in the literature for individual awareness.

Figure 611 - *Overview of Leadership Awareness*



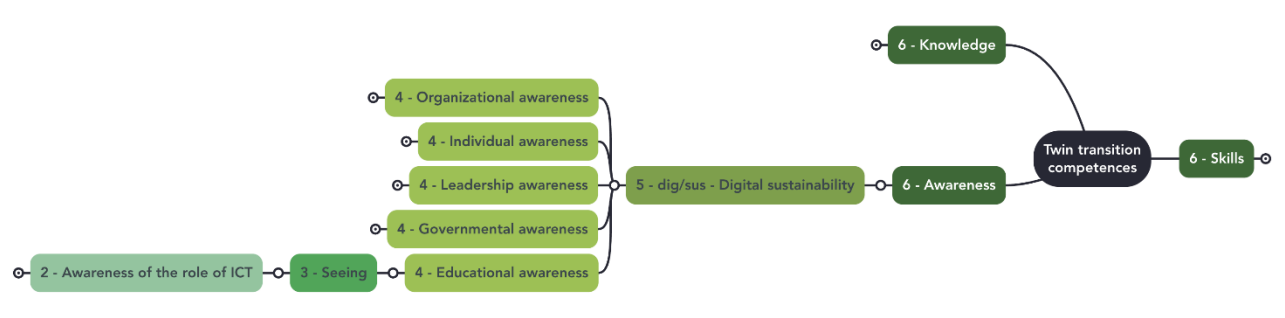
Leadership awareness (acknowledging) consists of the awareness of the challenges and benefits of D4S for competitiveness [55] and corporate culture[49]. **Leadership awareness (seeing)** consists of awareness of entrepreneurial opportunities of dual transformation[49] and changes due to technology developments[55].

Figure 7 -*Overview of Governmental Awareness*



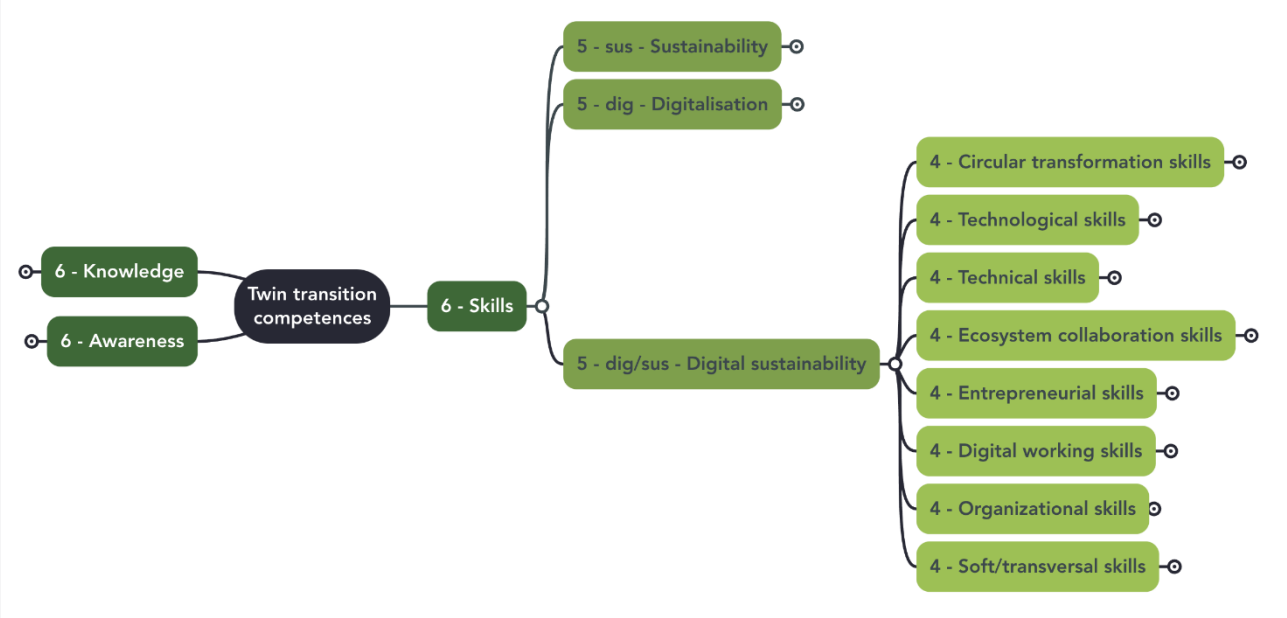
Governmental awareness is only identified in acknowledging the significance of digital transformation[55].

Figure 8 - *Overview of Educational Awareness*



Educational awareness is only identified as a seeing knowledge type, namely the awareness of the role of software (and ICT in general) for sustainability[43].

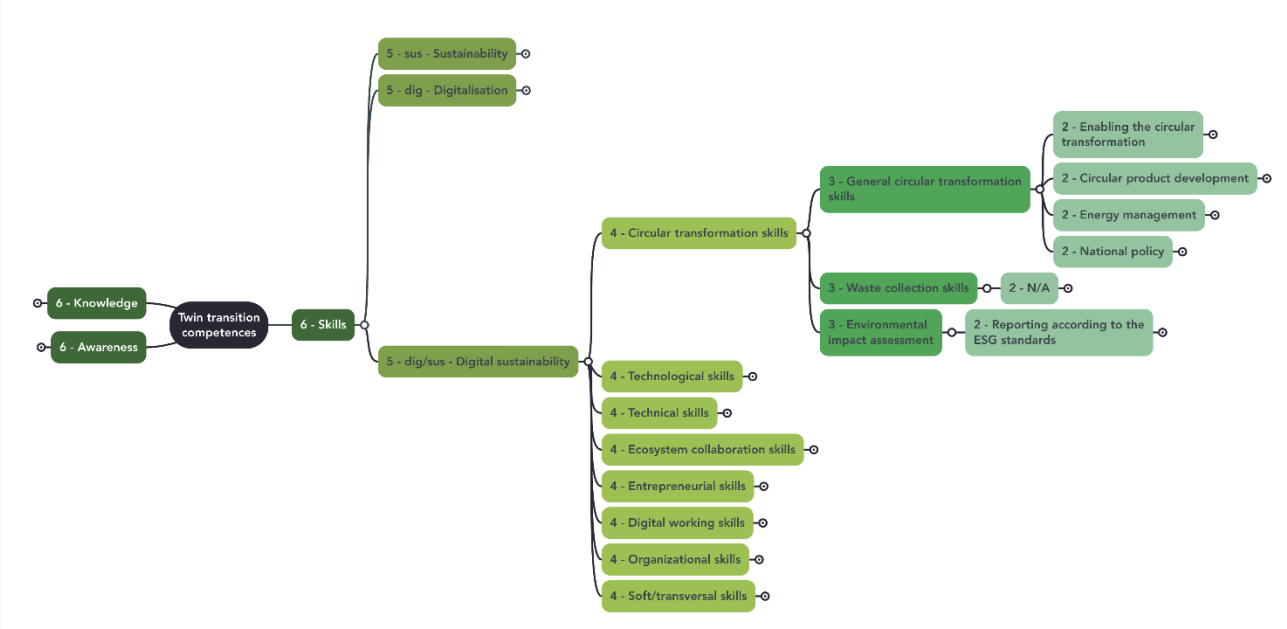
Figure 9 - *Overview of Skills*



2.4.3 Skills

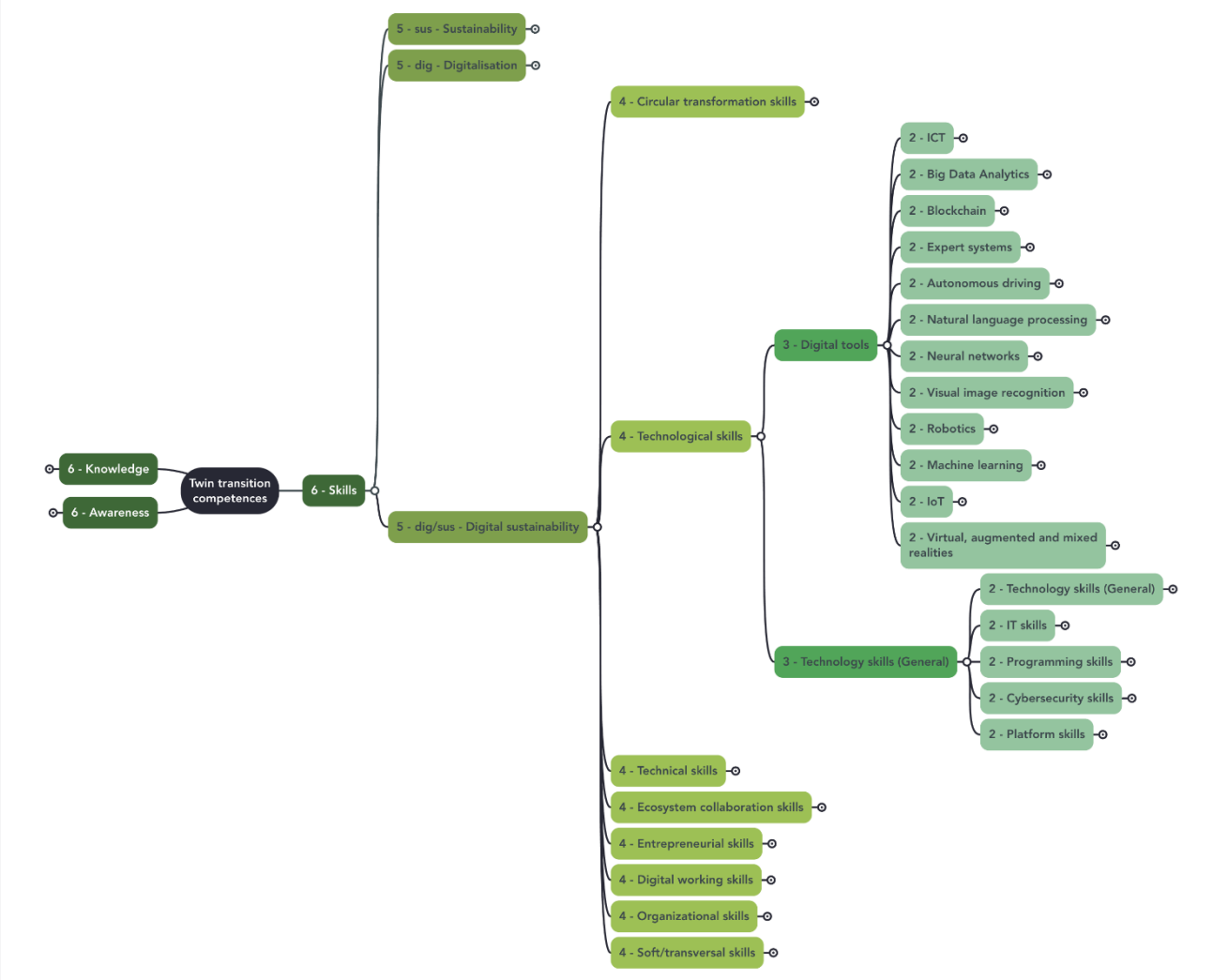
The analysis identifies key skills in the digital sustainability literature required to navigate the twin transition, which are categorized in the following main themes: Circular transformation skills, Technological skills, Technical skills, Ecosystem collaboration skills, Entrepreneurial skills, Digital working skills, Organizational skills and Soft/transversal skills.

Figure 10 - *Overview of Circular Transformation Skills*



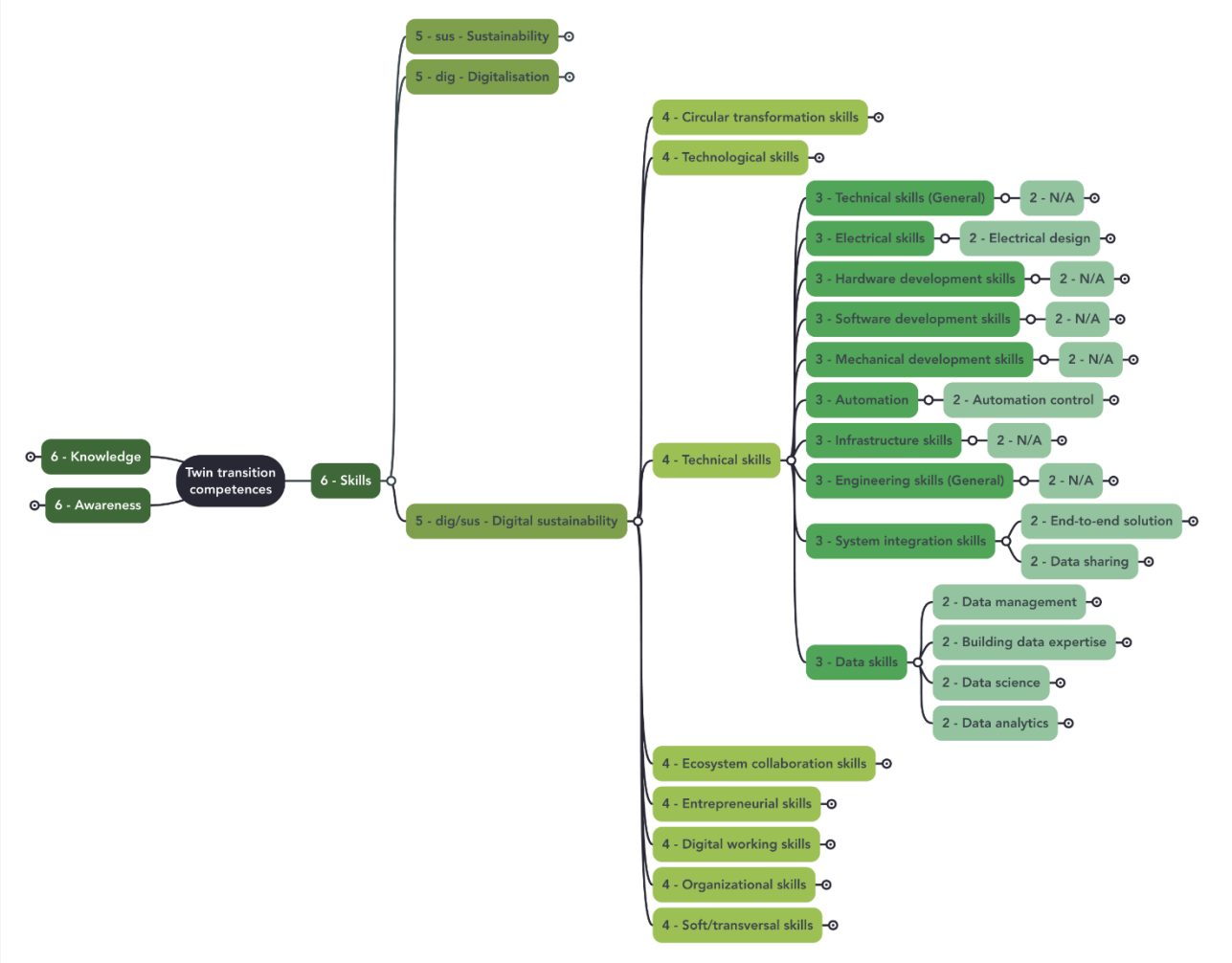
Circular transformation skills are essential for advancing towards a circular economy by optimizing the management of natural resources. Several key skills required for this transformation are identified through the literature analysis, including the facilitation of general circular processes[42,46], circular product development[49,57], energy management[57] and creating National policy[55,57,60]. Additionally, Hofmann Trevisan et al.[57] highlight various skills required in the waste sector specifically, including encouraging easy-to-recycle materials. While their study is specific to the waste sector, the underlying concept that waste is not a byproduct but a valuable resource holds relevance across all sectors. Lastly, to evaluate progress effectively, it is essential to utilize skills that quantify both the positive and negative environmental impacts through comprehensive environmental impact assessments, including standardized reporting methods[49,57].

Figure 11 - *Overview of Technological skills*



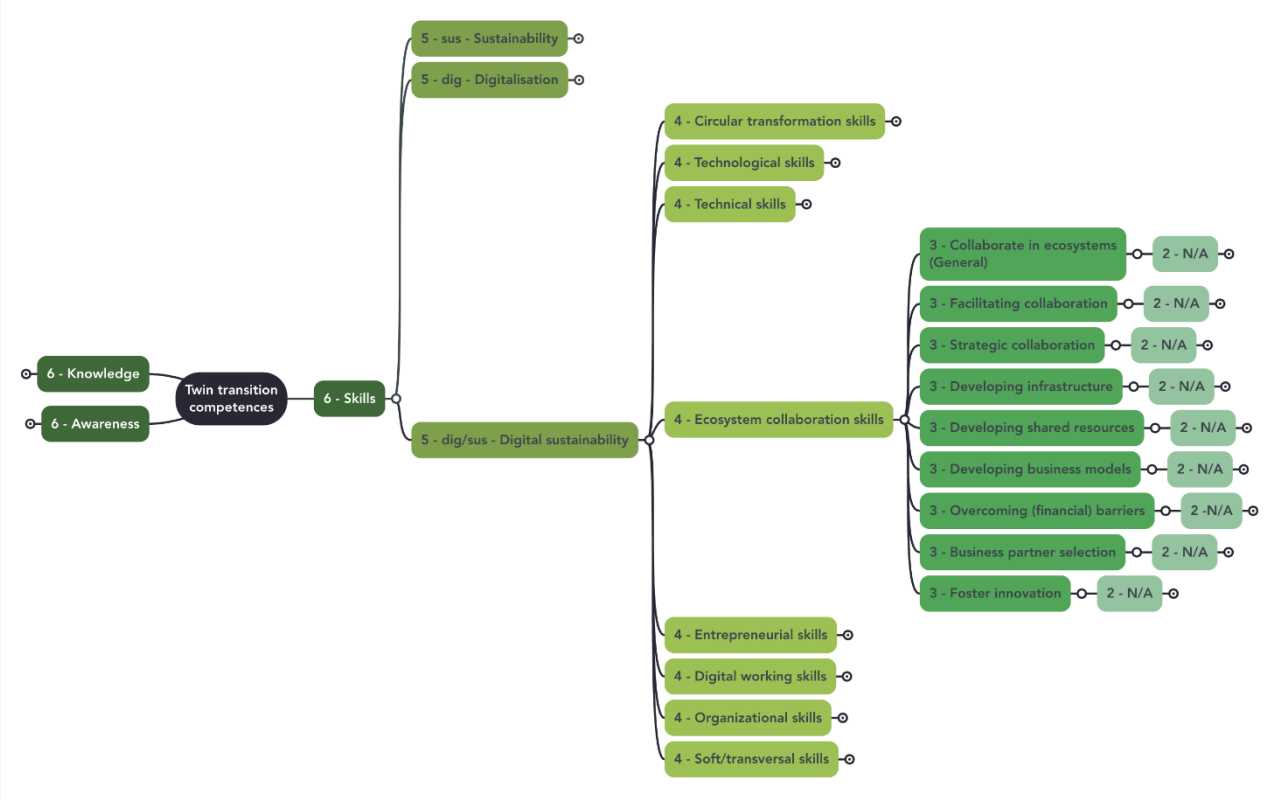
Technological skills involve capabilities required to effectively utilize particular digital tools, consisting of more general technological skills[37,54,77] such as IT skills[39,46] programming skills[25,39], cybersecurity skills[66] and platform skills[68]. The specific digital tools identified include: ICT[12], Big Data Analytics[39,66], Blockchain[39], expert systems, autonomous driving, natural language processing, neural networks, visual image recognition and robotics[15], machine learning[15,22,66], IoT[66] and Virtual, augmented and mixed realities[57].

Figure 12 - *Overview of Technical skills*



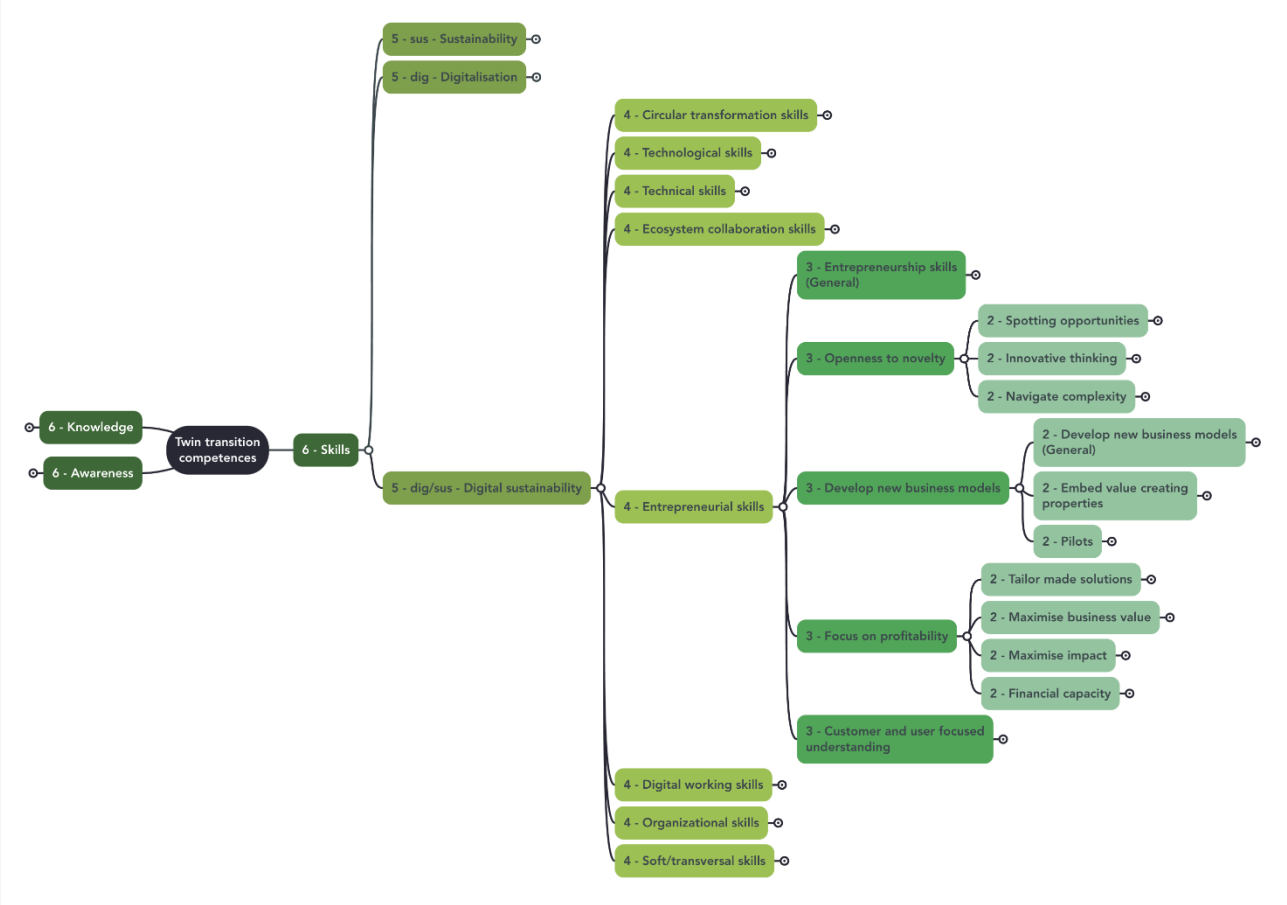
Technical skills are not tied to digital tools in particular; instead, they encompass the abilities required to work effectively across a variety of digital tools and applications and are divided into general technical skills[46], electrical skills, hardware-, software- and mechanical development and automation[25], infrastructure[39], general engineering skills[77], and system integration consisting of end-to-end solutions[25] and data sharing[34]. Finally, data skills encompass areas such as data management[41,51,72], building data expertise by working on own solutions[47], data science[37] and data analytics[41,47,51,66,68].

Figure 138 - *Overview of Ecosystem collaboration skills*



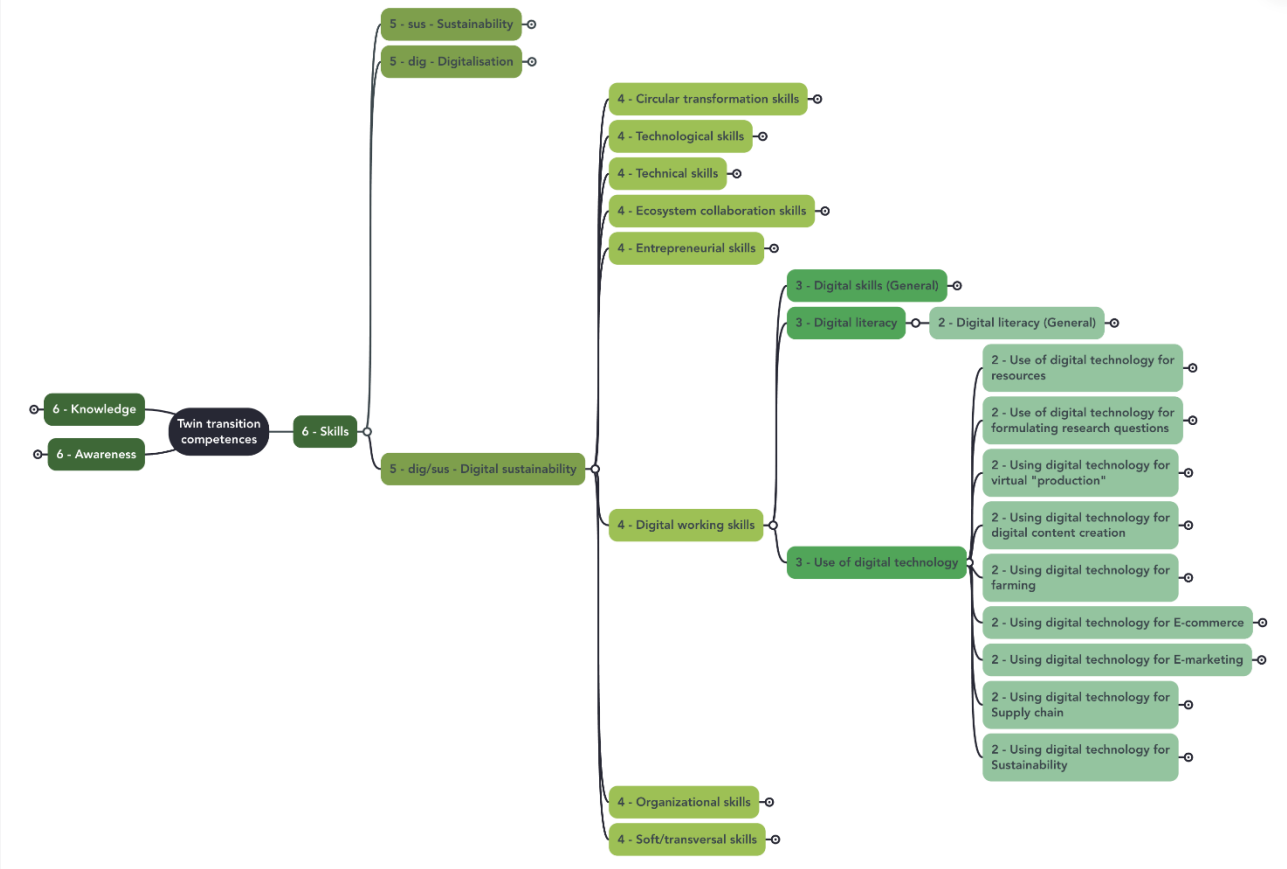
The analysis further indicates a growing need for **ecosystem collaboration skills**[7,25,51,60]. More specifically, ecosystem collaboration consists of facilitating such collaboration[7,11,37,57], strategic collaboration[25,37,57], developing infrastructure[7,39,57], developing shared resources[11,50,57], developing business models[50], overcoming (financial) barriers[37,57], business partner selection[25,42,50] and fostering innovation[21,44,57].

Figure 149 - *Overview of Entrepreneurial skills*



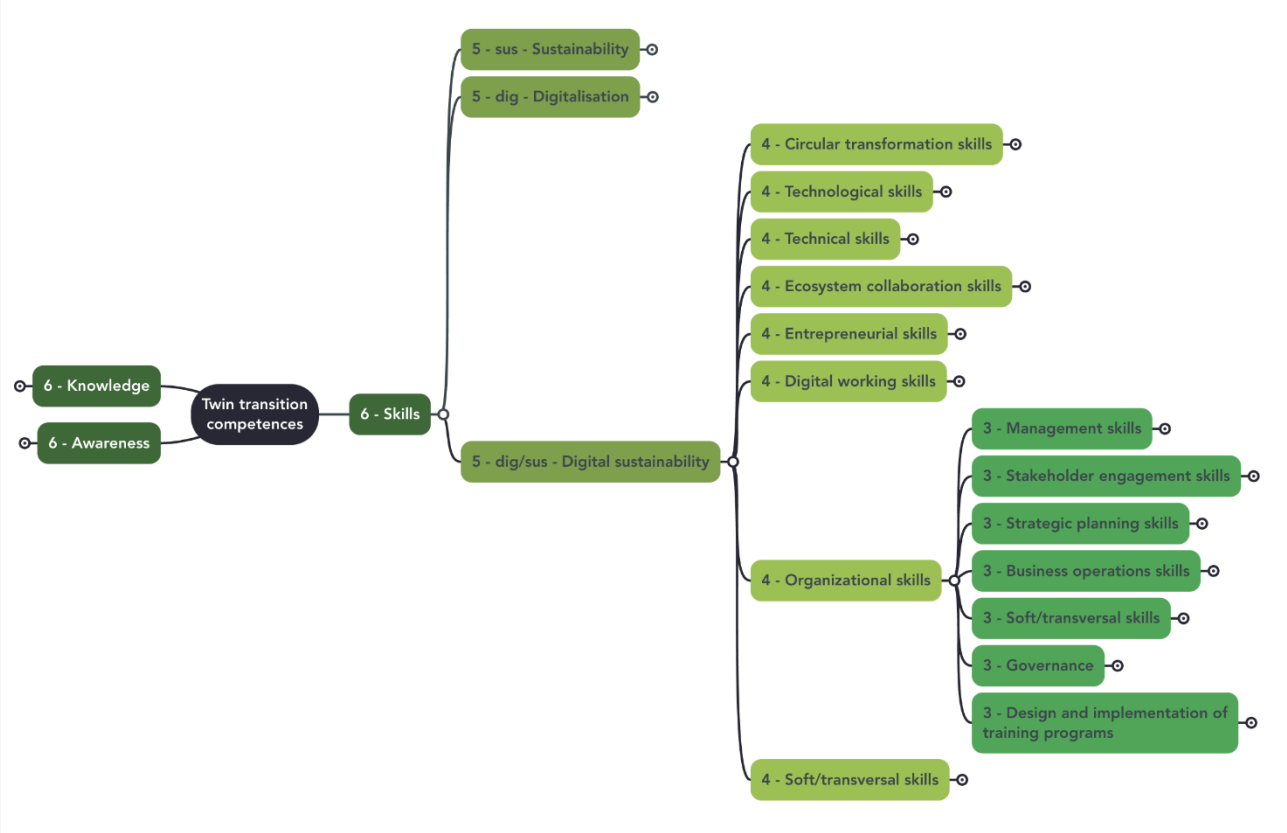
Entrepreneurial skills required for the twin transition partially overlap with the Digital Transformation Skills Framework of Bouwmans et al.[6], with additional skills unique to the twin transition. In the twin transition general entrepreneurship skills are necessary[66,77], and in more detail openness to novelty, meaning spotting opportunities[39,62,64], innovative thinking[62] and navigating complexity[36]. Furthermore, the twin transition necessitates skills for developing new business models in general[30,44,51,68], and more specifically skills to embed value creating properties in the core of the business model[7,36,39,55]. Additional skills are needed to pilot these new business models[30]. Another essential entrepreneurial skill is a focus on profitability, achieved through the development of tailored, profitable solutions[25], maximizing business value[25,46,48], maximizing impact[36,39,48] , or developing financial capacity[36,57]. Finally, there is a need for skills related to customer and user focused understanding[25].

Figure 20 - *Overview of Digital working skills*



In order to effectively work with digital technologies, there is a need to highlight several **digital skills,** namely general digital skills[51,62,64,77] and digital literacy in general[39,62]. Furthermore, the analysis identifies various applications of digital technologies, including resource management[52], the formulation of research questions[52], virtual product design[9], digital content creation[9], digital operations management[51], digital management information systems[51], e-commerce and e-marketing[51], supply chain[60] and sustainability[7,39,64].

Figure 21 - *Overview of Organizational skills*

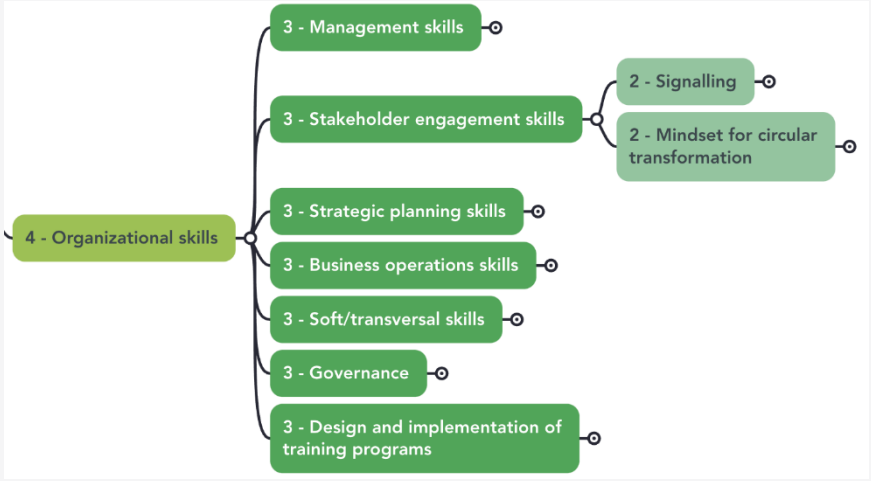


Organizational skills are divided into the following main categories of skills: management, stakeholder engagement, strategic planning, business operations, soft/transversal, governance, design and implementation of training programs.

Figure 152 - Overview of Organizational – Management skills

Within **management skills** the following different domains are identified: people management[77], project management[49,77], human resource management[36,39,40,55], and resource management[62].

Figure 16 -*Overview of Organizational – Stakeholder engagement skills*



Stakeholder engagement consists of signalling skills to identify market needs[39] and to have the right mindset to enable the circular transformation in relation with internal- and external partners[42].

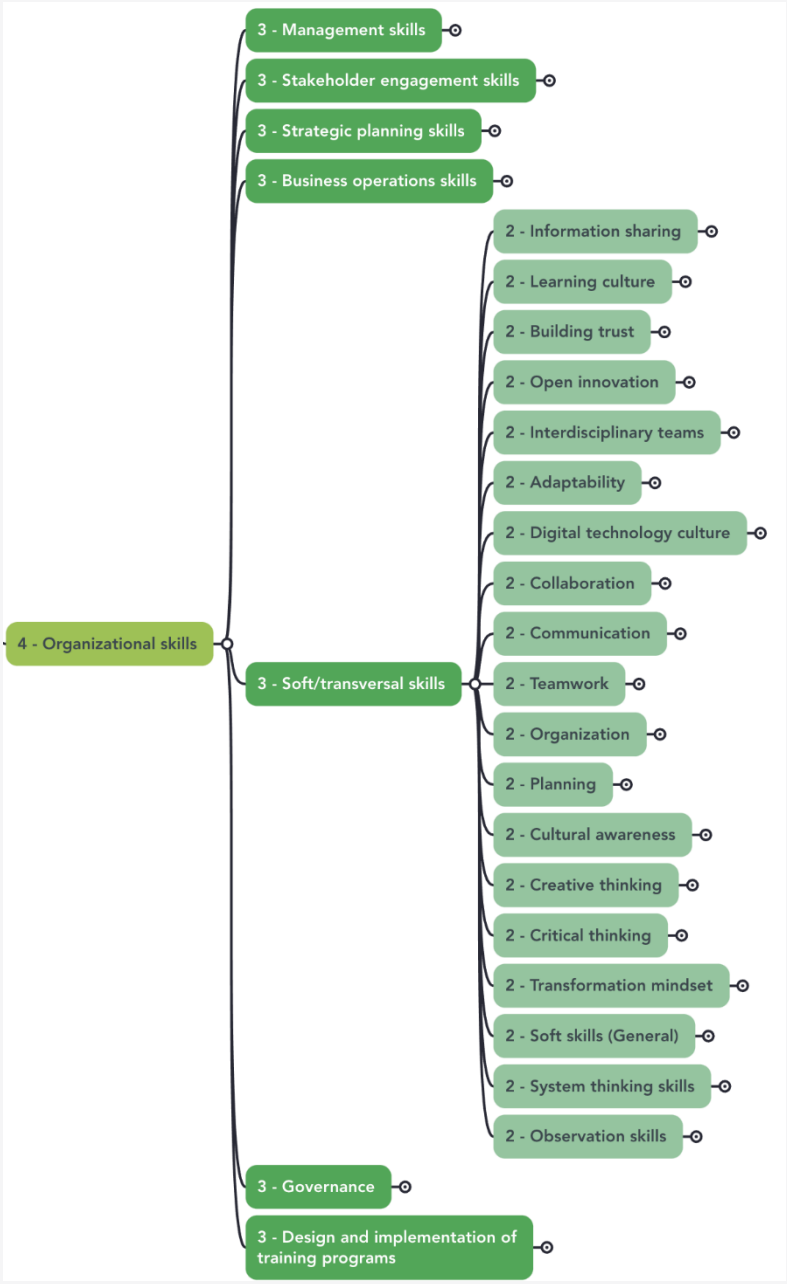
Figure 24 - *Overview of Organizational – Strategic planning skills*

Strategic planning may be categorized into strategy adaptation[7,36,44], strategy and goal alignment[7,34,36,44,48,50,51,55,62], strategic thinking[51], development of organizational strategies and policies[21,34,36,51] and by fostering a consistent digital response across the entire organization[36].

Figure 25 - *Overview of Organizational – Business operations skills*

Business operations skills concerns skills related to streamlining business operations[7,17,25,30,34,36,46,62].

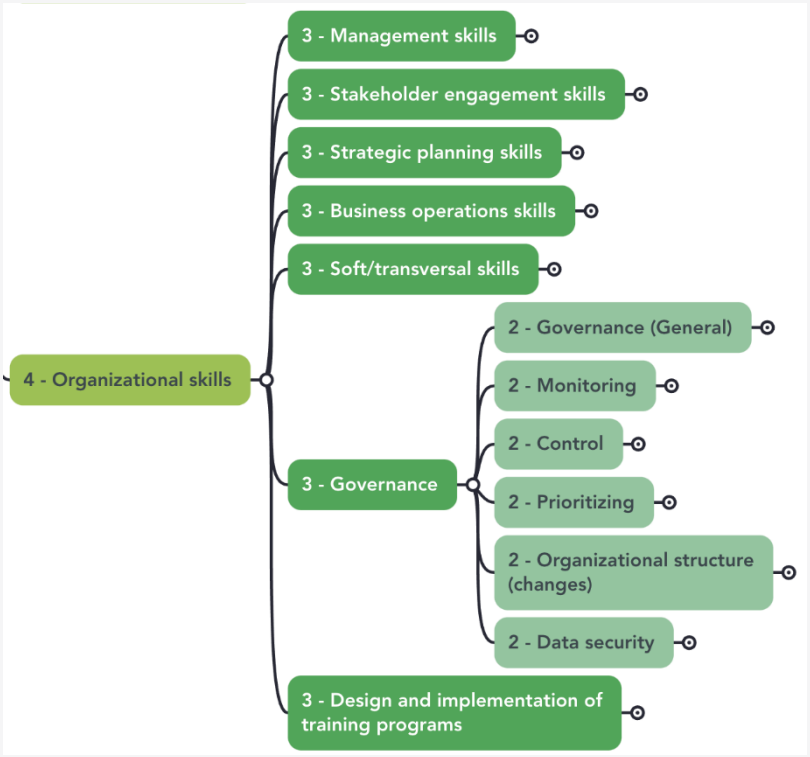
Figure 26 - *Overview of Organizational – Soft/transversal skills*



The literature extensively discusses **soft/transversal skills.** Soft/transversal skills related to an **organizational** level were grouped under organizational skills. This category encompass

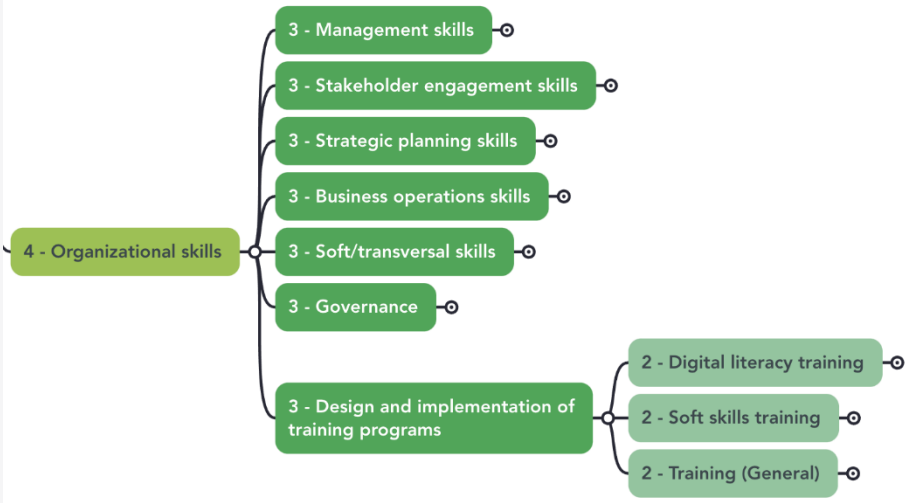
information sharing[32], learning culture[7,32,42,55,57], building trust[57], open innovation[7,34,44,60], interdisciplinary teams[7,32], adaptability[7], digital technology culture[32,34], collaboration[34,72], communication[17,34,51,54,72], teamwork[34], organization, planning and creative and critical thinking[51], cultural awareness[77], transformation mindset[60], soft skills in general[72], system thinking skills[50] and observation skills[36].

Figure 177 - *Overview of Organizational – Governance skills*



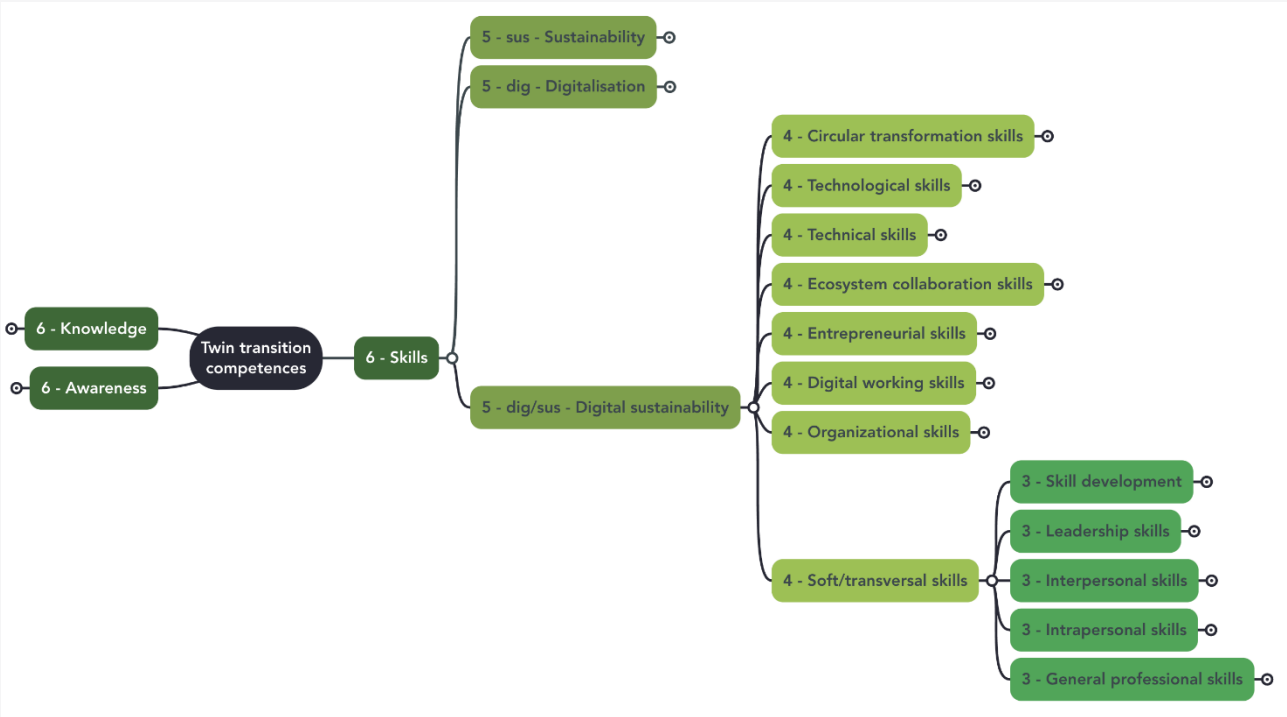
Governance refers to skills that are needed to organize the twin transition within an organization, and may be divided into general governance skills[17,32,34], monitoring[7,50], control[55], prioritizing[36,55], organizational structure changes[7,34,36,60] and data security[32,57].

Figure 28 - *Overview of Organizational – Design and implementation of training programs skills*



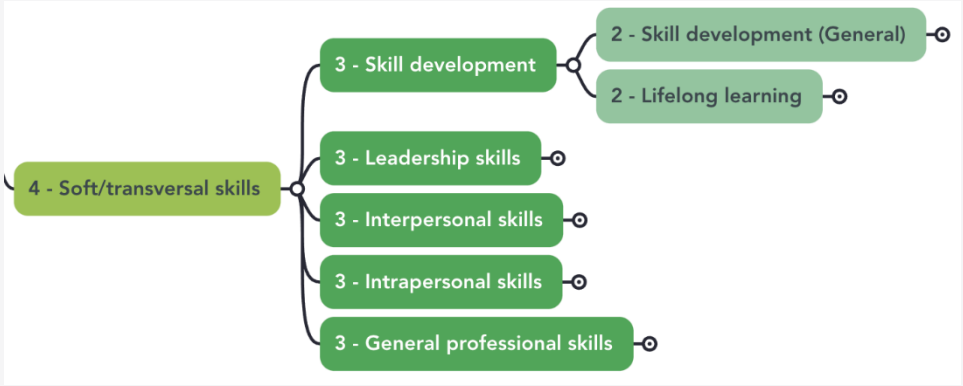
In relation to **design and implementation of training programs** on organizational level, various types of trainings for employees to prepare them for the twin transition were mentioned in the literature. It concerns digital literacy training[13,21,37], soft skills training[37] and training in general[13,32,34,55,57,60].

Figure 29 - *Overview of Soft/transversal skills*



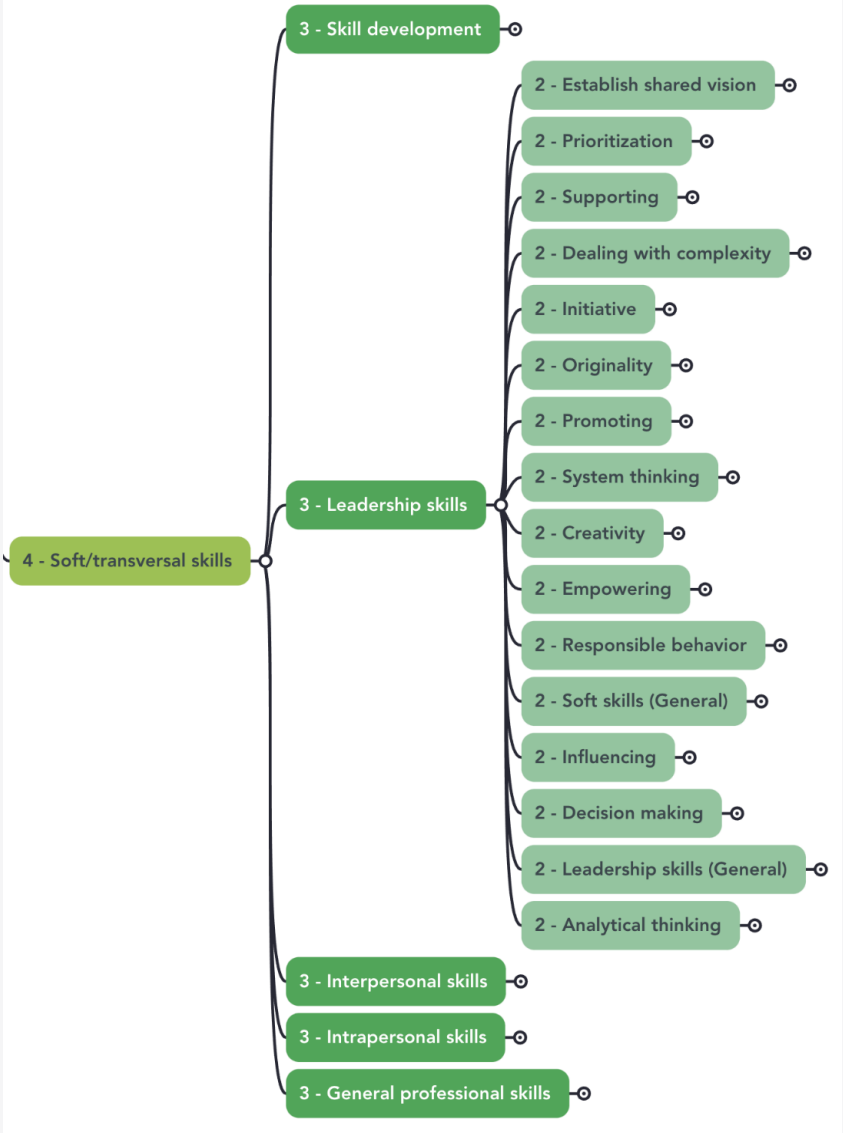
Moving to the **individual** level, the following main categories of **soft/transversal skills** are identified as well, such as (continuous) skill development and learning, leadership skills, interpersonal skills, intrapersonal skills and general professional skills. These are discussed in more detail below.

Figure 30 - *Overview of Soft/transversal – Skill development skills*



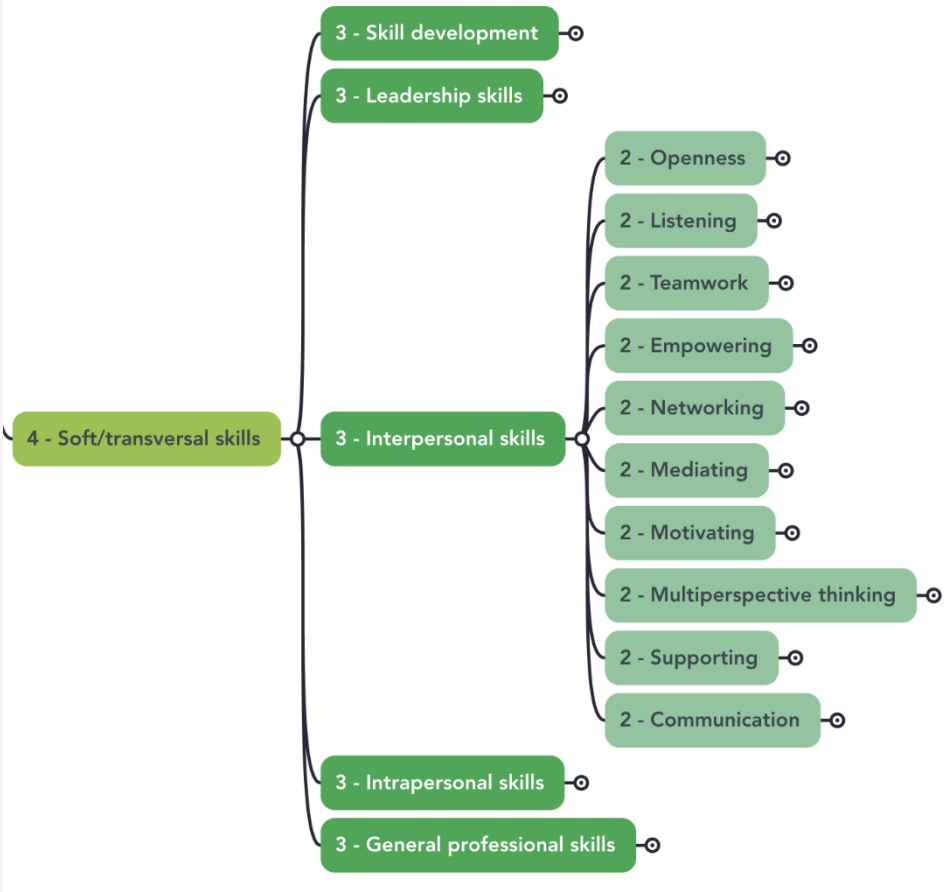
The category **skill development** discusses the skills needed to for re- and upskilling in general[36] and lifelong learning, which focusses on being able to continuously learn[42,43,51,76,77].

Figure 31 - *Overview of Soft/transversal – Leadership skills*



Leadership skills are the next group of soft/transversal skills on the individual level. This category encompasses establishing a shared vision[37,57], prioritization[37], supporting[34,37,49,55], dealing with complexity[48], taking initiative[37,51], originality[37], promoting[37,55], system thinking[48,66], creativity and empowering[37], responsible behavior[51,66], soft skills in general[37], influencing[55], decision making[44], leadership skills in general[51] and analytical thinking[37].

Figure 32 - *Overview of Soft/transversal – Interpersonal skills*

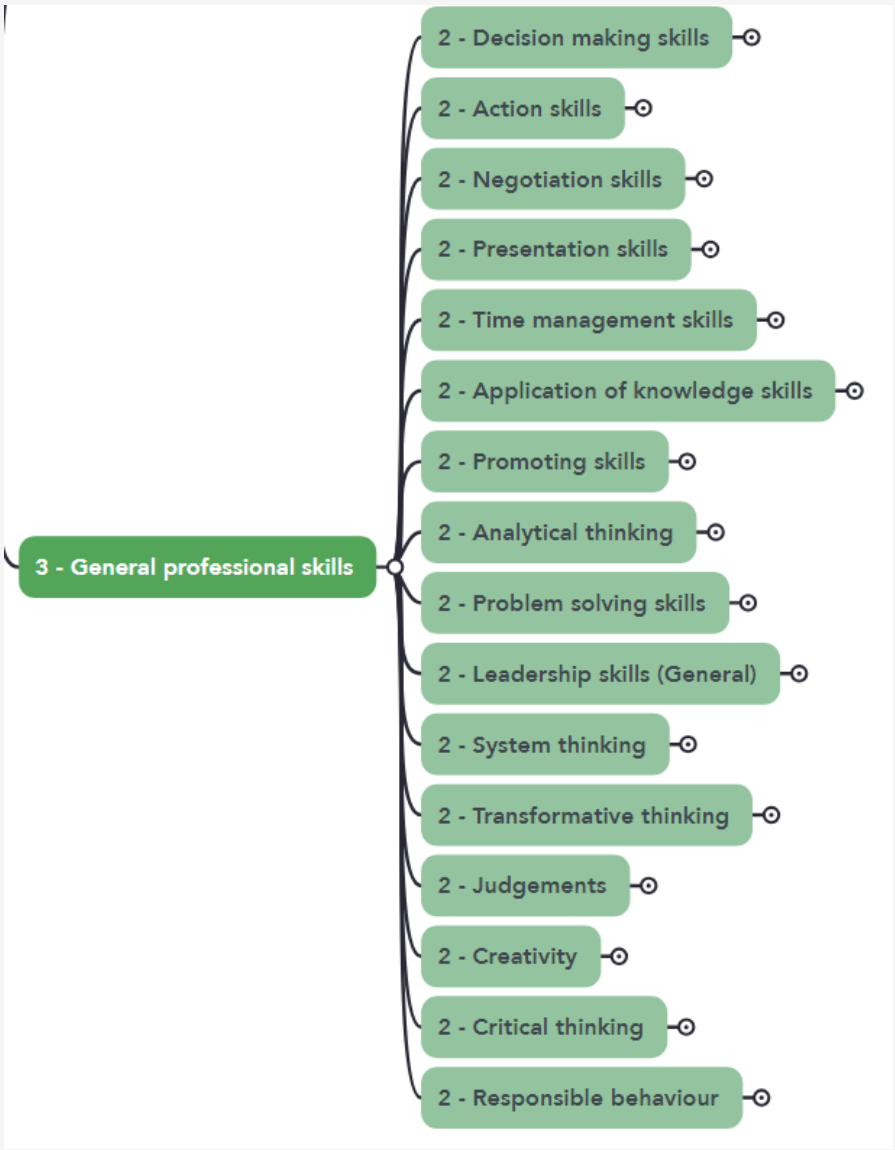


Additionally, in a complex world where ecosystems are necessary to create the right leverage, **interpersonal skills** are essential, comprising openness, listening[62], teamwork[62,66], empowering[66], networking[51,62,66], mediating[66], motivating[62,66], multiperspective thinking[43,62], supporting[62] and communication[43,51,62].

Figure 33 - *Overview of Soft/transversal – Intrapersonal skills*

Intrapersonal skills, additionally, help individuals to practice self-management in general, self-reflection, flexibility, dealing with complexity and independency[62], patience and taking initiative[66], adaptability[51,62,66], cognitive engagement[62,66,76] and accountability[62,66].

Figure 34 -*Overview of Soft/transversal – General professional skills*



Finally, the analysis shows various **general professional skills** such as decision making[49,62,66], negotiation[66], presentation skills, time management, action skills, skills to apply one's knowledge, promoting and analytical thinking[62], problem solving[62,66,74], leadership skills in general (even if the individual is not in a leadership position)[62,66], system thinking, transformative thinking and making the right judgements[43], creativity and critical thinking[43,62,66] and displaying responsible behaviour[51,62,66].

2.5 Conclusion and recommendations

Based on the results outlined above the following key conclusions of the reviewed literature are distilled, and translated into recommendations for the skills strategy to be developed.

The literature clearly indicates that the **twin transition is expected to fundamentally change institutions, companies, and labour markets**. At the same time, the twin transition is still in an **early stage**[23]. Only few companies are on a fundamental level embracing and synchronizing a digital and sustainability transformation[42]. **Awareness[49], use cases[22] and business models[30] are called for to inspire action**.

On the other hand, **companies are already experiencing skills shortages in the field of digital and sustainability transformation**. Working on the twin transition requires more and a larger variety of skills[15,72], so the literature shows. This is associated with higher education levels[15,55]. As the digital transformation at the same time is expected to lead to a reduction of low-skilled labour, which requires limited creativity[15,54,61,71], an urgent skill gap is apparent. Institutes of higher education need to alter curricula and ways of teaching but cannot keep up with the fast pace of technological development[74]. Also, re- and upskilling of the existing workforce would not be reached by only altering formal education[50]. Therefore, **collaborative efforts between educational institutes, companies, trade organizations, and other local partners are necessary to tackle this challenge**[11].

The thematic analysis has delivered an overview of **an enormous number of different skills** mentioned in the literature. Looking at the overall data structure, it seems obvious that it is **impossible to expect the full skill set in a single employee**. Also, not all skills will be necessary in every role, for example consider technological skills which cover a range of specific applications, or skills like virtual product design or governance. It is noted furthermore that part of the skills needs have been identified on an organizational level ('organizational capabilities'), and others on the level of individual employees, which calls for specification in developing skill profiles. A complicating factor is, however, that research into the twin transition is far from satisfied to a level that clear differentiations per sector, or type of company can be made. Also, it is not clear at this point which new roles or jobs will arise. This makes an establishment of which skills are needed for which job profiles cannot be established based on the current knowledge base. It is even indicated that companies also do not exactly know which skills they need, and hence are not able to assess possible skill gaps[72]. This highlights the need to increase the insights in this field.

On a positive note, there is **clear overlap with both digital transformation and sustainability skills, which means that companies can build on an existing set of skills**[42]. On the other hand, it is yet unclear what is needed to create synergy out of a combination of skills, or what changes when existing skills are applied in a different domain. This again requires additional research.

In terms of recommendations this literature review therefore firstly calls for **active cooperation between multiple stakeholders, including research institutes, trade organizations, policymakers, and companies to build the knowledge necessary for tailored roles and associated skill sets**. This could for instance be done starting with reviewing de current European e-CF profiles. Considering the swiftly evolving field of the twin transition (both in practice and academia) new developments should furthermore be actively monitored and integrated into a skills strategy.

What is convincingly argued in the literature, is that **transversal and soft skills, and (ecosystem) cooperation skills** are needed for many workers in the twin transition. On the other hand, **basic digital skills are also likely to be essential in any twin transition role**. It is therefore suggested that a skills strategy taps into this need, in order to reduce the anticipated skills gap proactively. Companies that already need a specific set of job-related skills can currently provide on-the-job training to build on a general skills foundation.

Also, there is a clear call for the role of leadership, entrepreneurship and development of use cases. While developing use cases and business model is outside of the direct scope of the Digital4Sustainability project, searching after cooperation with other twin transition initiatives or educational institutes can be beneficial. Furthermore, raising awareness, sharing inspiring examples, and the identified knowledge needs can be seemingly integrated in a skills strategy.

A final message that clearly speaks from the literature is that there **cannot be a 'one-size-fits-all' in re- and upskilling for the twin transition**. This has to do with different regional circumstances[10,23], different engagement in the twin transition of sectors[13,21,57], company size[20], and the maturity level of an organization or existing organizational capabilities[32]. In a skills strategy it would be wise to take these differences into account.

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2.6 Appendix A

Reference short	Title	Journal/Book	Source type	Sector/Type	Country	Thematic analysis
Aagaard & VanHaverbeke (2024)	The twin advantage: Leveraging digital for sustainability in business models	Business Model Innovation Game Changers and Contemporary Issues	book chapter	not applicable	not applicable	Yes
Benedetti et al. (2023)	Digitalization in Europe: A potential driver of energy efficiency for the twin transition policy strategy	Socio-Economic Planning Sciences	research article	not applicable	Europe	No
Ben-Zvi & Luftman (2022)	Post-Pandemic IT: Digital Transformation and Sustainability	Sustainability	research article	various	various	Yes
Bertola & Vandi (2021)	Fashion Design Education Towards Twin Transition. Developing multidisciplinary skills for future professionals	Global Fashion Conference 2021	conference proceeding	fashion industry	Europe	Yes
Bianchini et al. (2023)	The environmental effects of the "twin" green and digital transition in European regions	Environmental and Resource Economics	research article	not applicable	Europe	No
Breiter et al. (2024)	Dynamic Capabilities for the Twin Transformation Climb: A Capability Maturity Model	Information Systems Frontiers	research article	various	not specified	Yes
Budai et al. (2023)	Digital Competence Development in Public Administration Higher Education	Sustainability	research article	public administration education	Europe	No
Christmann et al. (2024)	The twin transformation butterfly	Business & Information Systems Engineering	conceptual	not applicable	not applicable	Yes
Collini & Hausemer 2023	Place-based pathways for the twin transition: the role of systemic change agents	Competitiveness Review: An International Business Journal	conceptual	not applicable	not applicable	Yes
Dabbous et al. (2023)	The impact of digitalization on entrepreneurial activity and sustainable competitiveness: A panel data analysis	Technology in Society	research article	various	various	Yes
Dekeyrel & Fessler (2024)	Digitalisation: an enabler for the clean energy transition	Journal of Energy & Natural Resources Law	commentary	construction SMEs	Europe	Yes
del Socorro Encinas-Grijalva et al. (2024)	Business readiness for dual transformation: an analysis of business capabilities for digital and sustainable transformation	Discover Sustainabiity	research article	not specified	Mexico	Yes
Dovleac et al. (2023)	Shaping the Inclusivity in the New Society by Enhancing the Digitainability of Sustainable Development Goals with Education	Sustainability	research article	education	Europe	No
El Hilali (2020)	Reaching sustainability during a digital transformation: a PLS approach	International Journal of Innovation Science	research article	various	Morocco	Yes
Feroz et al. (2023)	Identifying organizations' dynamic capabilities for sustainable digital transformation: A mixed methods study	Technology in Society	research article	not specified	International	Yes
Gallina et al. (2024)	Business model development concept for SMEs in the era of twin transition	Procedia Computer Science	conference proceeding	SMEs	not applicable	No

George & Schillebeeckx (2022)	Digital transformation, sustainability, and purpose in the multinational enterprise	Journal of World Business	conceptual	MNEs	not applicable	No
Gonzales Ehlinger & Stephany (2023)	Skills or Degree? The Rise of Skill-Based Hiring for AI and Green Jobs	SSRN Electronic Journal	research article	not applicable	United Kingdom	Yes
Goropečnik et al. (2024)	Efficiency of European Wood Science and Technology Educational Programmes in Including Green and Digital Topics	Drvna Industrija	research article	education - wood science and technology	Europe	No
Graf-Drasch et al. (2023)	Driving twin transformation - The interplay of digital transformation and sustainability transformation	ECIS 2023 Research Papers	systematic lit review	not applicable	not applicable	Yes
Gumbi et al. (2024)	Exploring Pre-Service Teachers' Perspectives on the Integration of Digital Game-Based Learning for Sustainable STEM Education	Sustainability	research article	universities	South-Africa	Yes
Hazrat et al. (2023)	Developing a Skilled Workforce for Future Industry Demand: The Potential of Digital Twin-Based Teaching and Learning Practices in Engineering Education	Sustainability	research article	education - engeneering	not specified	Yes
Heldal et al. (2023)	Sustainability Competencies and Skills in Software Engineering: An Industry Perspective	Journal of Systems and Software	research article	software engineering	International	Yes
Hofmann Trevisan et al. (2023)	Barriers to employing digital technologies for a circular economy: A multi-level perspective	Journal of Environmental Management	research article	manufacturing	International	Yes
Hofmann Trevisan et al. (2024)	Skills for the twin transition in manufacturing: a Systematic Literature Review	NA	book chapter	manufacturing	not applicable	No
Jurmu et al. (2023)	Exploring the Role of Federated Data Spaces in Implementing Twin Transition within Manufacturing Ecosystems	Sensors	research article	manufacturing	Finland	Yes
Katsamakas (2024)	From Digital to AI Transformation for Sustainability	Sustainability	editorial	not applicable	not applicable	Yes
Korucuk et al. (2022)	Assessing Green Approaches and Digital Marketing Strategies for Twin Transition via Fermatean Fuzzy SWARA-COPRAS	Axioms	research article	logistics	not applicable	No
Kurniawan et al. (2023)	Decarbonization in waste recycling industry using digitalization to promote net-zero emissions and its implications on sustainability	Journal of Environmental Management	systematic lit review	waste recycling industry	not applicable	No
Kurpick Rasor et al. (2023)	An integrative view of the transformations towards sustainability and digitalization: The case for a dual transformation	Procedia CIRP	conference proceeding	manufacturing	Germany	Yes
Kurpick, Kuhn et al. (2023)	Framework for dual transformation: A systematic literature review on the interplays between digitalization and sustainability	2023 IEEE Conference on Technologies for Sustainability	conference proceeding	manufacturing	not applicable	Yes
Ma et al. (2024)	Role of big data and technological advancements in monitoring and development of smart cities	Heliyon	systematic lit review	smart city	not applicable	No

Maliphol & Walter (2023)	A Systematic Review of Digital Skills and Sustainable Development	2023 Portland International Conference on Management	conference proceeding	not applicable	not applicable	Yes
Martínez-Peláez et al. (2023)	Role of Digital Transformation for Achieving Sustainability: Mediated Role of Stakeholders, Key Capabilities, and Technology	Sustainability	systematic lit review	MSMEs	not applicable	Yes
Meijer (2024)	Perspectives on the twin transition	Information Polity	systematic lit review	not applicable	not applicable	No
Montresor & Vezzani (2023)	Digital Technologies and Eco-Innovation. Evidence of the Twin Transition from Italian Firms	SSRN Electronic Journal	research article	not specified	Italy	No
Napathorn (2022)	The development of green skills across firms in the institutional context of Thailand	Asia-Pacific Journal of Business Administration	research article	various	Thailand	Yes
Ortega-Gras et al. (2021)	Twin Transition through the Implementation of Industry 4.0 Technologies: Desk-Research Analysis and Practical Use Cases in Europe	Sustainability	research article	various	Europe	Yes
Paiho et al. (2023)	Twin transition in the built environment – Policy mechanisms, technologies and market views from a cold climate perspective	Sustainable Cities and Society	research article	buildings sector	FInland	Yes
Panori (2024)	Digital space in the forefront of twin transition	Digitally Disrupted Space: Proximity and New Development Opportunities for Regions and Cities	book chapter	not applicable	not applicable	No
Parida et al. (2019)	Reviewing Literature on Digitalization, Business Model Innovation, and Sustainable Industry: Past Achievements and Future Promises	Sustainability	editorial	manufacturing	not specified	Yes
Pasnicu (2023)	Skills-First Approach in the Context of the Twin Transition	Journal of Economic Development, Environment and People	research article	not applicable	Romania	No
Peters et al. (2024)	Sustainability in Computing Education: A Systematic Literature Review	ACM Transactions on Computing Education	systematic lit review	education - computing	not applicable	Yes
Philblin et al. (2022)	Understanding how digital transformation can enable SMEs to achieve sustainable development: A systematic literature review	Small Business International Review	systematic lit review	SMEs	not applicable	No
Pospelova et al. (2023)	User and Professional Aspects for Sustainable Computing Based on the Internet of Things in Europe	Sensors	research article	IoT in smart city	Europe	Yes
Rahnama et al. (2022)	Collaboration in Value Constellations for Sustainable Production: The Perspective of Small Technology Solution Providers	Sustainability	research article	small technology solution providers (SMEs)	Sweden	Yes
Ramalho Ribeiro et al. (2023)	Skill Needs for Sustainable Agri-Food and Forestry Sectors (II): Insights of a European Survey	Sustainability	research article	agri-food and forestry	Europe	Yes

Rehman et al. (2023)	Twin transitions & Industry 4.0: Unpacking the relationship between digital and green factors to determine green competitive advantage	Technology in Society	research article	various	Pakistan	No
Robertsone & Lapina (2023)	Digital transformation as a catalyst for sustainability and open innovation	Journal of Open Innovation: Technology, Market, and Complexity	systematic lit review	not applicable	not applicable	No
Rosario & Diaz (2022)	Sustainability and the Digital Transition: A Literature Review	Sustainability	systematic lit review	various	not applicable	Yes
Ruiz-Rodriguez (2023)	Advanced digital skills of the Spanish population from 2015 to 2021. Socioeconomic and geographical factors according to an ordered probit model	Telematics and Informatics	research article	not applicable	Spain	No
Sá et al. (2021)	Digitainability—Digital Competences Post-COVID-19 for a Sustainable Society	Sustainability	research article	not specified	not specified	Yes
Semerikov et al. (2020)	Sustainability in Software Engineering Education: a case of general professional competencies	E3S Web of Conferences	conference proceeding	education - software engineering	not applicable	No
Setyaningrum & Muafi (2023)	Green human resource management, green supply chain management, green lifestyle: Their effect on business sustainability mediated by digital skills	Journal of Industrial Engineering and Management	research article	manufacturing	Indonesia	No
Sharma et al. (2023)	Overcoming barriers to implement digital technologies to achieve sustainable production and consumption in the food sector: A circular economy perspective	Sustainable Production and Consumption	research article	food industry	India	Yes
Shouraki et al. (2024)	Digital Sustainability for Human Resource Management Canvas Meta-Synthesis Approach	Journal of Management and Sustainability	research article	not specified	not specified	Yes
Singh et al. (2024)	Assessing digital capability for twin transition and profitability: From firm and people perspectives with leadership support as moderator	Business Ethics, the Environment & Responsibility	research article	various	India	No
Spaltini, Acerbi et al. (2024)	Toward a technology roadmapping methodology to enhance sustainable and digital transition in manufacturing	Production & Manufacturing Research	research article	manufacturing	Europe	No
Spaltini, Terzi et al. (2024)	Development and implementation of a roadmapping methodology to foster twin transition at manufacturing plant level	Computers in Industry	research article	manufacturing	Italy	No
Stanef-Puică et al. (2022)	Green Jobs—A Literature Review	International Journal of Environmental Research and Public Health	systematic lit review	not applicable	International	No
Suciu et al. (2023)	Core Competence—As a Key Factor for a Sustainable, Innovative and Resilient Development Model Based on Industry 5.0	Sustainability	conference proceeding	not specified	Europe	Yes
Teichmann et al. (2024)	Digitalization, Demographic Change and Decarbonization: Eight Pivotal Competencies for Learning Factories	Learning Factories of the Future	systematic lit review	not applicable	Education	Yes

Tsaples et al. (2024)	Synergies and Challenges: Exploring Organizational Perspectives on Digital Transformation and Sustainable Development in the Context of Skills and Education	Buildings	research article	not specified	Europe	Yes
Tubis et al. (2023)	Supply Chain in the Digital Age: A Scientometric–Thematic Literature Review	Sustainability	systematic lit review	supply chain	not applicable	No
Urenholt et al. (2022)	Towards the Twin Transformation: A View on Designing Circular and Digital Organisations	NA	PhD thesis	manufacturing	Denmark	Yes
van Erp & Rytter (2023)	Design and operations framework for the Twin Transition of manufacturing systems	Advances in Production Engineering & Management	research article	manufacturing	not specified	Yes
Vaquero et al. (2021)	European green deal and recovery plan: Green jobs, skills and wellbeing economics in Spain	Energies	research article	not applicable	Spain	No
Veit et al. (2024)	Twin transition in practice	Zeitschrift Für Angewandte Organisationspsychologie (GIO)	conceptual	not applicable	Management	No
Xu et al. (2022)	Digital Sustainable Entrepreneurship: A Digital Capability Perspective through Digital Innovation Orientation for Social and Environmental Value Creation	Sustainability	research article	SMEs	China	Yes
Zhang & Jin (2023)	How Does Digital Transformation Increase Corporate Sustainability? The Moderating Role of Top Management Teams	Systems	research article	A-share listed companies	China	Yes
Bouwmans et al. (2024)	Developing the digital transformation skills framework: A systematic literature review approach	PLoS ONE	systematic lit review	not applicable	not applicable	calibration
Brundiers et al. (2021)	Key competencies in sustainability in higher education—toward an agreed-upon reference framework	Sustainability	research article	not applicable	not applicable	calibration
Evans (2019)	Competencies and Pedagogies for Sustainability Education: A Roadmap for Sustainability Studies Program Development in Colleges and Universities	Sustainability	research article	not applicable	not applicable	calibration
Finnveden & Schneider (2023)	Sustainable Development in Higher Education—What Sustainability Skills Do Industry Need?	Sustainability	research article	not applicable	not applicable	calibration
Redman & Wiek 2021	Competencies for Advancing Transformations Towards Sustainability	Frontiers in Education	systematic lit review	not applicable	not applicable	calibration
Venn et al. (2022)	Competencies of Sustainability Professionals: An Empirical Study on Key Competencies for Sustainability	Sustainability	research article	not applicable	not applicable	calibration

2.7 Appendix B

Source	Key term used	Page	Definition key term	Page	Sustainability definition
Aagaard & VanHaverbeke (2024)	twin transition	p. 228	"Accordingly, and in response to the urgent need for sustainable development, the European Commission has championed the concept of twin transition (TT) or digitally enabled sustainable transition, emphasizing the role of digital technologies in driving eco-friendly transformations, while emphasizes the integral connection between sustainability and digital transitions, viewing them as co-dependent elements critical for future progress (European Commission, 2024a)."	p. 230	"As firms navigate the complexities of this dual transition, they are compelled to adopt a holistic perspective that encompasses environmental, social, and economic dimensions (Bocken et al., 2014; Lüdeke-Freund & Dembek, 2017) in their business development."
Benedetti et al. (2023)	twin transition		not available		not available, focus is on green
Ben-Zvi & Luftman (2022)	digital transformation AND sustainability		not applicable	p. 2	"Furthermore, digital transformation is expected to have transformative effects not only on businesses, but also on society and the planet itself—what is referred to as “sustainability”."
Bertola & Vandi (2021)	twin transition	p. 4	"This coupling of digital and sustainable transformation, the so-called ‘twin transition’, is in fact considered to be a multiplier of the several effects that each of these two processes can separately produce."		not available, mixed messages, focus seems to be on green transformation (emissions & resources)
Bianchini et al. (2023)	twin transition	p. 877	"the nexus between digital and green transformations"		not available, focus is on green
Breiter et al. (2024)	twin transformation	p. 2	""“a value-adding interplay between digital and sustainability transformation efforts that improve an organization by leveraging digital technologies for enabling sustainability and leveraging sustainability for guiding digital progress” (Christmann et al., 2024, p. 7)."		not availble, focus is on environmental, social, and economic sustainability
Budai et al. (2023)	digital AND sustainability		not applicable		not available
Christmann et al. (2024)	twin transformation	p. 7	"a value-adding interplay between digital and sustainability transformation efforts that improve an organization by leveraging digital technologies for enabling sustainability and leveraging sustainability for guiding digital progress"	p. 4	"As a foundation, we understand sustainability transformation as an organizational change process that is multi-layered, complex, and relates simultaneously to environmental, societal, governmental, regulatory, and individual factors (Lahtinen and Yrjo¨la¨ 2019; Oghazi and Mostaghel 2018; Seidel et al. 2014)."

Collini & Hausemer 2023	twin transition	p. 5	"a systemic shift from one equilibrium (the status quo or the so-called “regime” in the transition literature) to a new equilibrium."	p. 3/4 p. 7	"For instance, using an MLP approach, sustainability transitions have been defined as a “shift or system innovation towards more sustainable technical configurations encompassing not only new green technologies, but also corresponding changes in markets, user practices, policy and cultural discourses and governing institutions” (Geels, 2004)." "the digital and green transition"
Dabbous et al. (2023)	twin transition	p. 1	"Moreover, the rapid transition towards becoming a digital economy [12] and the emergence of the twin transitions concept have conveyed an incontestable complementarity between digital and green transitions. As such, the new plan launched by the European Commission [13] advocates the use of digital technologies to enhance environmental sustainability."	p. 2	"Whereby, social sustainability entails the conservation of “social capital” or “moral capital,” economic sustainability is achieved when capital is maintained and enables actors to consume while keeping them as well off as before, and environmental sustainability requires the protection of “natural capital” [39,40]."
Dekeyrel & Fessler (2024)	twin transition	p. 186	"As this paper will show, turning digitalisation into an enabler for the clean energy transition – a ‘twin’ green and digital transformation of the European energy sector – offers numerous possibilities and opportunities"	p. 185	not available, but focus is on "a sustainable, secure and affordable energy future"
del Socorro Encinas-Grijalva et al. (2024)	dual transformation	p. 2	"In this context, Dual Transformation (DT) is characterised by the convergence of two transformative processes in the operational models of companies that allow them to maintain their competitiveness and integration into global value chains [24]. These processes are Digital Transformation (DgT) and Sustainable Transformation (ST). DT is a strategic approach that enables companies to maintain their competitive edge while integrating themselves into global value chains [25]."	p. 2	focus is on human well-being and environmental sustainability
Dovleac et al. (2023)	digitainability		digitalisation + sustainability		not available, focus is on SDG4 and the digital divide
El Hilali (2020)	digital transformation and sustainability		not applicable	p. 7	"To link it with sustainability, a digital transformation should help companies to increase their financial numbers, their social footprint on communities and to reduce their negative externalities on environment."

Feroz et al. (2023)	sustainable digital transformation	p. 3	"a reconfiguration process of an organization's core strategy that focuses on aligning novel digital technologies such as big data, IoT, artificial intelligence, cloud, mobile, and social media technologies with the organization's sustainability goals."	p. 2	"While sustainability has three dimensions: social, economic, and environmental [67], this study focuses mainly on the environmental aspect. Environmental sustainability is one of the most important principles of sustainability, which emphasizes that in satisfying our needs and using the planet's resources, we must make accommodations to preserve the environment's quality, and the natural habitat's ecological landscapes should be sustained for the sake of future generations [22,69]."
Gallina et al. (2024)	twin transition	p. 524	"the digital and green transition as well [3, 4]. The digital transition plays an essential role, whereby generated data on the one hand, and digital technologies on the other hand are seen as enablers in the context of the twin transition [5] and contribute to reaching the Sustainable Development Goals by 2030 [6]."		not available, mentioning of SDGs in definition reference to economic, ecological, and social pillar in conceptualisation
George & Schillebeeckx (2022)	digital sustainability		not available	p. 4	reference to ESG and call for linking to regeneration paradigm"Through regeneration, the focus of corporate sustainability expands beyond reducing negative externalities of resource use – the dominant sustainability paradigm in the extractive economy - towards the explicit inclusion of and accounting for positive impact – the paradigm of the regenerative economy (Schillebeeckx & Merrill, 2021)."
Gonzales Ehlinger & Stephany (2023)	twin transition	p. 2	"The twin transition encompasses, potentially, two of the main drivers of change in the labour market: the growing digitalisation of economic processes and an economic shift towards greater environmental sustainability. The interplay between these two transitions creates unique synergies."		not available, focus is on green
Goropečnik et al. (2024)	green AND digital		not applicable		not available, focus is on green

Graf-Drasch et al. (2023)	twin transformation	p. 4	"a fundamental organisational change process that enables organisations to address digital and societal challenges synergistically by harnessing the power of DT to enable ST and leveraging ST to redesign DT."	p. 3	"The three sustainability dimensions are subsumed through the concept of sustainable development and target the protection of natural resources (i.e., ecological sustainability) and provide social and economic welfare (i.e., social and economic sustainability) (Brundtland, 1987). In line with Zimmer and Järveläinen (2022) and Raworth (2017), we define ST as fundamental organisational changes in cultures, structures, and practices that aim to improve an organisations' triple bottom line to ensure well-being within the limits of earth carrying capacity."
Gumbi et al. (2024)	digital AND sustainability		not applicable		not available
Hazrat et al. (2023)	digital transformation AND sustainability		not applicable		not available
Heldal et al. (2023)	sustainability AND software		not applicable	p. 2	"Hence, "sustainability" refers to the capacity of a system to endure for a certain amount of time [15]. Within the conceptualisation of sustainability put forward by the Brundtland Commission in 1987 [16], the system in question is Earth itself and the period of time, while not exactly specified, includes many generations into the future. The Brundtland definition thus encompasses two aspects: distributive justice ("the essential needs of the world's poor, to which overriding priority must be given" [16]), but also intergenerational justice, for which the preservation of the biosphere is a prerequisite."
Hofmann Trevisan et al. (2023)	digitalization AND sustainability		not applicable		not available, focus is on circular economy
Hofmann Trevisan et al. (2024)	twin transition	p. 3	""an intertwined and simultaneous green and digital transition to offset companies' carbon footprint" (Rehman et al., 2023, p. 1)"		not available, focus is on green
Jurmu et al. (2023)	twin transition	p. 1	"the need to increasingly tackle sustainability challenges and to change corporate culture towards sustainable principles, while utilizing digitalization—understood here as highly malleable compositions of established key enabling technologies such as IoT, cloud, AI, and data management in general—in the process."	p.1	"Sustainability as a concept encompasses environmental, economic, and social dimensions, all of which can also have interdependencies [4]."

Katsamakas (2024)	AI transformation AND sustainability		not applicable	p. 1	"In this article, we take a broad view that includes environmental, social, and economic sustainability strategies and related terms, such as social responsibility, and business and technology for good."
Korucuk et al. (2022)	twin transition green digital transformation	p. 2 p. 2	"Supporting sustainability with technology has led to the development of the twin transition paradigm [1]." "Green digital transformation, in this sense, means the constructive use of digitalization and green technology in the connection of business processes, activities, products and models, with the purpose of making companies more ecologically sustainable [6]."		not available, focus is on green
Kurniawan et al. (2023)	digitalization AND sustainability		not applicable		not available, focus is on green and circular economy
Kurpick Rasor et al. (2023)	dual transformation	p. 615	"a transformation approach that holistically and strategically combines both digitalization and sustainability in the company in order to leverage synergies and manage mutual interdependencies in the best possible way."	p. 614	"The sustainability transformation addresses the ecological, economic, and social goals in equal measure [6]"
Kurpick, Kuhn et al. (2023)	dual transformation	p. 175	"For the synergetic development of the business potentials associated with sustainability and digitalization, the two transformation processes must be approached integratively in the sense of a dual transformation [6]."		not available; focus is on economic, social and enviromental
Ma et al. (2024)	digital technology AND sustainability		not applicable		not available, focus is on green
Maliphol & Walter (2023)	digital sustainability		not available		not available, focus is on green
Martínez-Peláez et al. (2023)	sustainable digital transformation		not available		not available, focus is on economic, social and environmental
Meijer (2024)	twin transition	p. 36	"the transformational connection between technology and environmental sustainability – the 'twin transition' (Almansour, 2022)"	p. 37	"While the concept of sustainability is applied increasingly broadly, our analysis focuses primarily on environmental sustainability (SDGs 13 (climate action), 14 (life below water) and 15 (life on land)) and its relations to economic development."
Montresor & Vezzani (2023)	twin transition	p. 2	"The green and digital transitions are thus linked, and so intrinsically linked to be considered as "twin transitions" (EC, 2020)."		not available, focus is on green
Napathorn (2022)	green		not applicable		not available
Ortega-Gras et al. (2021)	twin transition	p. 2	the twin digital and green transitions		not available, focus is on green

Paiho et al. (2023)	twin transition	p. 1	"the combination of digital technologies and European Green Deal goals, to achieve sustainable solutions supporting the creation of impactful, net-zero carbon and a resilient built environment"	p. 3	"Sustainability is typically evaluated from three perspectives, which include social, economic and environmental criteria."
Panori (2024)	twin transition	p. 118	"the overlapping space between digital and green transformation processes."		not available, focus is on green
Parida et al. (2019)	digitalization AND sustainability		not applicable		not available
Pasnicu (2023)	twin transition		not available		not available
Peters et al. (2024)	IT AND sustainability		not applicable	p. 3	"The commonly used Brundtland sustainability definition encompasses two aspects: distributive intragenerational justice (“the essential needs oftheworld’s poor, to which overriding priority must be given”) [251, 37], but also intergenerational justice, for which the preservation of the biosphere is a prerequisite." Analyzes different conceptualizations of sustainability in computing education
Philblin et al. (2022)	digital transformation AND sustainability		not applicable	p. 2	"Sustainability is defined as “development that meets the needs ofthe present without compromising the ability of future generations to meet their own needs” (UNESCO, 2015)."
Pospelova et al. (2023)	IoT AND sustainability		not applicable	p. 1	"Sustainability is a paradigm for thinking about a future in which environmental, societal, and economic considerations are balanced in the pursuit of an improved quality of life: “meeting the needs of the present without compromising the ability of future generations to meet their own needs” [1,2]."
Rahnama et al. (2022)	twin transition	p. 2	"an intertwined, simultaneous green and digital transition to reach a zero carbon and zero waste economy [15]"	p. 3	"Sustainability has been characterized as well-adjusted incorporation of human activities’ social, environmental, and economic performance to benefit current and future generations through a circular economy [25]."
Ramalho Ribeiro et al. (2023)	digital skills AND sustainability		not applicable	p. 6	"a sustainable food system ecompasses environmental, health, and social benefits as well as fairer economic gains [6]."
Rehman et al. (2023)	twin transition	p. 1	"an intertwined and simultaneous green and digital transition to offset companies’ carbon footprint"		not available, focus is on green

Robertsone & Lapina (2023)	digital transformation AND sustainability		not applicable	p. 2	"In the current research, sustainability is considered the result of sustainable practices that secures the sustainable development of the companies. Sustainability practices, according to Curran (Curran, 2009), “allow for satisfactory outcomes for humans and the environment while fulfilling the social and economic needs of current and future generations.""
Rosario & Diaz (2022)	digital transition AND sustainability		not applicable	p. 1 p. 2	"The concept integrates multiple aspects of the current society, including ecological, social, and economic concerns. It also aims to balance environmental protection and economic growth." Difficutly in defining is discussed.
Ruiz-Rodriguez (2023)	digital skills AND sustainability		not applicable		not available
Sá et al. (2021)	digitainability digital sustainability	p. 2 p. 10	"digitalization + sustainability" characeteristics of digital sustianability: intergenerational justice, regenerative capacity, economic use of resources, risk reduction, absorptive capacity, ecological and economic added value	p. 13	"environmental, social and economic"
Semerikov et al. (2020)	software AND sustainability		not applicable	p. 1	"sustainable development"
Setyaningrum & Muafi (2023)	digital skills AND sustainability		not applicable	p. 4	"Business sustainability is the ability of firms to keep the balance between their environment, social, and economic or financial performance, which is also known as Triple Bottom Line (TBL)."
Sharma et al. (2023)	digital technology AND sustainability		not applicable		not available, focus is on green
Shouraki et al. (2024)	digital sustainability		not available	p. 108	"The dimensions of sustainability include people, planet, and profit (Aagaard, 2019)."
Singh et al. (2024)	twin transition	p. 2	"the simultaneous transformation of both individuals and firms in response to digitalization (Chen et al., 2023)."		not available
Spaltini, Acerbi et al. (2024)	twin transition	p. 2	"The authors refer to these twofold and indivisible transitions, sustainable and technological, as Twin Transition (TT) (Rehman et al., 2023)."		not available, focus is on economic and environmental
Spaltini, Terzi et al. (2023)	twin transition	p. 2	"digitally-enabled configurations of operations processes to achieve both business and environmental goals, referred to as Twin Transition (TT) (Stefan et al., 2022)."		not available, focus is on economic and environmental

Stanef-Puică et al. (2022)	technologies AND green		not applicable		not available, focus is on green
Suciu et al. (2023)	digitalization AND sustainability		not applicable	p. 1	not availble, reference to "economic, social and environmental perspective"
Teichmann et al. (2024)	digitalization AND sustainability		not applicable		not available, focus is on green
Tsaples et al. (2024)	digital transformation AND sustainability		not applicable		not available
Tubis et al. (2023)	sustainable digitalization		not available	p. 9	"Researchers point to pursuing a holistic achievement of sustainable digitalization to benefit people, prosperity, and the planet and implement the Sustainable Development Goals [23]."
Urenholt et al. (2022)	twin transformation	p. 25/26	"The twin transformation, or transition as the European Commission labels it, represents the coherent and simultaneous pursuit of the circular and the digital transformation, for which the two individual agendas mutually benefit each other."		not available, focus is on circular economy
van Erp & Rytter (2023)	twin transition	p. 92	"a sustainable and digital transition of the industry, which will be of increasing importance as an industrial strategy in the future [1]."		not available
Vaquero et al. (2021)	digital transformation AND green		not applicable		not available, focus is on green
Veit et al. (2024)	twin transition	p. 158	"The term “twin transition” refers to a simultaneous transition to a more sustainable and digital society and argues for synergies between both developments (EU-Commission 2022)."		not available, focus is on green
Xu et al. (2022)	digital transformation AND sustainability		not applicable		not available, focus is on green
Zhang & Jin (2023)	digital transformation AND sustainability		not applicable	p. 1/2	"Sustainability is a complicated notion that refers to economic, environmental, and social development that serves the demands of the present without interfering with the needs of future generations [13–15]."
Bouwmans et al. (2024)	digital skills		not applicable		not applicable
Brundiers et al. (2021)	sustainability competencies		not applicable		not available
Evans (2019)	sustainability competencies		not applicable		not available

Finnveden & Schneider (2023)	sustainability skills		not applicable		not available
Redman & Wiek 2021	sustainability competencies		not applicable	p. 1	"To achieve the Sustainable Development Goals (SDGs) by addressing persistent sustainability challenges such as climate change, biodiversity loss, and socio-economic injustices requires ambitious and whole-scale transformations of societies worldwide (UNESCO, 2017; Scoones et al., 2020)."
Venn et al. (2022)	sustainability competencies		not applicable		not available

D2.1.Annex.C Analysis of market reports

3.1 Approach

It was expected that up-to-date labour market reports with relevant information are not readily available, if at all, given the emerging nature of the field compared to other fields. To address this, initial general desk research was conducted to determine available sources mainly at the European level. Similarly, at the national level, partners were asked to search for labour market reports on digital for sustainability, but if these were not available, they were asked to write a short report on at least the current state of the digital sector and the field of sustainability in general.

The initial desk research focused on pre-existing information on skills, mostly at the European level, and on delineating the roles and skills that are most relevant and worth studying in the rest of this skills needs analysis. Previous projects and studies were examined to avoid duplication and determine the most efficient approach.

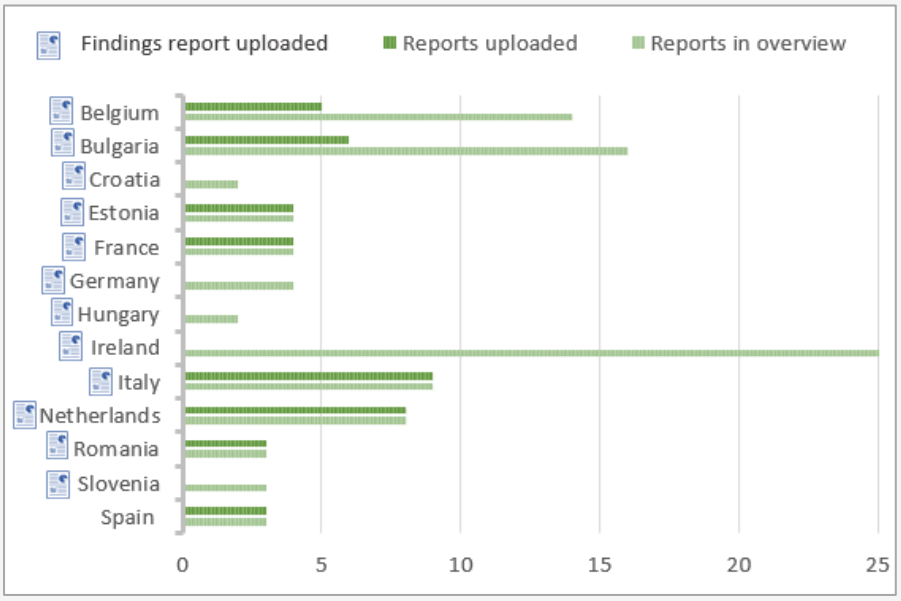
European and more specific national labour market reports were studied to gain insights into the current labour market. The twin transition labour market was analysed in as much detail as possible. If there was any doubt whether an item should be included in the study, the basic rule was to include it. In most cases, labour market reports were too general to identify specific job and skill needs related to digital for sustainability. In that case, or if no reports had been distilled from data, partners were asked to find European, but especially national databases on their labour market and more specifically the labour market of the twin transition. No such databases on twin transition were found in any of the countries.

3.2 Results

Beforehand the expectation was that this would be the most difficult data-collection method, since the field of digital for sustainability is not a separate part of the labour market. Also the twin transition is mainly just covered by information from the digital sector and the sustainability sector put next to each other. This expectation turned out to come true.

In total 98 sources were found that were related to the national labour market situations in the consortium countries. There was no reports dedicated to the labour market situation of the twin

transition, but some include information on both digital and sustainability jobs. In some cases only information from national digital and national sustainability strategies was available.



In total 42 sources that were considered relevant and were used for more detailed analysis. For twelve of the consortium countries an initial findings report was drafted, in which the situation in the country was sketched based on the available sources.

Figure 18 The input for the labour market analysis

3.3 Main findings

As for the labour market in the field of digital sustainability, the demand for skilled workers in this field is expected to grow strongly in the coming years.

If the trend continues, it is expected that for some sectors the demand will even be so high that it cannot be met. Demand is already disproportionately distributed across different sectors and will continue to be so, with some sectors experiencing less to no demand. While some job losses are anticipated, overall the impact is expected to be positive.

Exactly how big the demand for digital sustainability will be is difficult to say based on currently available data. In general, data is available on labour market developments in ICT and data is available on the growing demand for 'green occupations', but exact data on digital and sustainability is lacking. For all countries, the demand for both skilled ICT staff and staff skilled in sustainability is expected to continue to grow.

There will be a particular demand for skilled staff in sustainability in relation to the **circular economy** (especially focused on **supply chain** and **waste management**), **energy and utilities** (**solar, wind and climate technology**), **logistics and transport** and **construction**, and to a lesser

extent in **agriculture** and **manufacturing**. **Sector-specific sustainability skills** will increasingly be in demand.

Overall, the service sector is expected to be little affected by the green transition, with the exception of **finance, law, architecture, science, engineering** and **ICT**.

There are emerging professions in this area, such as **environmental consultants (ESG), carbon auditors, responsible digital educators** and **responsible digital managers**. **Data managers, middle managers** and **HR managers** will be particularly affected. In the ICT field, greater demand is expected for professionals skilled in **developing environmentally sustainable solutions** and **refining existing systems for greater sustainability and efficiency**, with positions such as **software analysts, ICT systems analysts, cyber security specialists, testers** and **data analysts**. Also, skills in **green marketing** and **sustainable supply chains** are emphasised.

This is strongly linked to European laws and regulations such as the EU Corporate Sustainability Reporting Directive (CSRD), the EU Corporate Sustainability Due Diligence Directive (CSDDD), the EU Packaging and Packaging Waste Regulation (PPWR), the Ecodesign for Sustainable Products Regulation (ESPR), and the EU Emissions Trading System (EU ETS), to name a few (details can be found in for example the overview of initiatives included in Europe's Green Deal[6] and Deloitte's Sustainability Regulation Outlook[7]).

Overall, the demand for STEM skills in general is expected to increase, along with professional, transversal and lifelong learning skills. And also that a combination of more traditional skills with new skills and soft skills will be needed. In many countries, the retirement of the current workforce plays a role in the growing labour shortage.

Several reports also highlight the need to upskill and reskill the current workforce in digital and sustainable skills. Many countries have introduced incentives.

For example, manuals are provided on (upcoming) workforce development. In a number of countries, reasonably standardised role descriptions are available and sometimes teaching and training materials. Role descriptions can serve as a basis for HR policies and for curriculum design by education and training providers. In some cases, teaching materials are already available for primary education. It also happens in some countries that there is even already a legal

[6] Council of the European Union. (n.d.). European Green Deal. Retrieved October 13, 2024, from https://www.consilium.europa.eu/en/policies/green-deal/

[7] Brennan, S. et al. (2024). Sustainability regulation outlook 2024. Deloitte Insights. https://www2.deloitte.com/us/en/insights/environmental-social-governance/sustainability-regulation-outlook.html

requirement to include the topic of sustainability in all curricula of formal education. There are also other measures, such as vouchers and subsidies.

Every country has formulated both a digital strategy and a strategy focused on sustainability. These documents have generally been developed by different government departments and sometimes appear to be completely separate. However, the more recent the versions of these strategies are, the more the overlap between the two areas is addressed in these strategies, i.e. a discussion of sustainability aspects in the digital strategy and vice versa.
When digital and sustainability are discussed together, the recommendations still mainly focus on the carbon footprint and energy savings; broader aspects with themes such as ethics, privacy and inclusiveness are often left out, with a few exceptions. A 'just' transition that does more justice to the broad scope of the SDGs is on the digital sustainability agenda in only a limited number of countries.

Recommendations on digital, in particular, vary widely between countries, due to large differences between the extent to which a country is digitally developed. There is also variation in the approach to sustainability. This is where the nature of business activities and sector organisation come into play, e.g. certain sectors are more represented in one country than another and one country has more SMEs than another. This means that issues and challenges, and thus recommendations and actions, may differ to a greater or lesser extent from country to country and often from region to region.

3.4 Analysis

The analysis was done on a country level. For each of the consortium countries the relevant labour market reports were scanned and a summary was made of the status of the digital for sustainability field. These were put together to create country summaries which served as input for the main findings.

Belgium	Belgium is actively working on its green and digital transition. The Green Skills Roadmap (2022) outlines the need for green skills in Flanders. Important findings are: • The green transition is necessary and is likely to accelerate in the coming years and have an overall positive impact on jobs and economic growth; • The green transition will have an uneven impact on the different sectors; • There are **specific technical**

	skills needs due to the green transition, but **there will be an even greater need for overall STEM skills, lifelong learning and professional and transversal skills;** • Challenges are: The lack of a culture of lifelong learning, already existing skills shortages, and retirement of current workforce between 2022-2030. Overall, around 26% of jobs are expected to be significantly affected by the green transition, requiring either improved skills (16%), new and emerging skills (4%) or the green transition leading to increased demand for these jobs (6%). These types of **green jobs are highly concentrated in the circular economy, utilities (energy) and construction sectors**, and to a **lesser extent in manufacturing**. It is estimated that around 74 % of jobs are unlikely to be significantly affected by the green transition; this high percentage is due to the high number of jobs in the services sector, which remains largely unaffected. Very few jobs would be at risk as a result of the green transition. Particulary, the ***circular economy*** requires an upskilling of the workforce in different areas. Most importantly, employees need to better understand the whole value chain. This requires new combinations of skills from employees: a combination of traditional skills (such as manual skills) and more **new skills (such as material sciences**); and a combination of **soft skills (such as service skills)** and **hard skills (such as programming, operating and repairing equipment**). The ***energy and utilities sector*** is at the heart of the green transition, as electricity and heating will require the most radical overhaul of all sectors. This is clearly reflected in the growth of the need for specific skills in the field of renewable energy, and broader professional skills to effectively manage and implement the transition that will take place. Regarding the skills needed for the ***manufacturing industry,*** a need is expected for further training of current employees in four key green themes: **sustainable design and engineering techniques, (renewable) energy, efficient and circular production and green business models**. Regarding the ***logistics and transport sector***, the transition to green mobility includes electrification of the transport sector, a modal shift, hydrogen applications, charging infrastructure, etc. There will be jobs in clean energy (including hydrogen), transport ('modal shift') and circular economy. The green transition will not only require **more social skills, such as teamwork, communication and networking**; but also more **ICT skills, analytical skills and knowledge of environmental regulation**. This will affect different types of jobs: managers, transport experts, planning experts and administrative staff. All types of skills are equally important: professional technical skills, professional skills, cross-sectoral skills (STEM skills, analytical skills, management skills, soft skills, etc.) and environmental knowledge and awareness skills. As a knowledge and service economy, the ***services sector*** has the highest number of workers in Flanders. Many

	of the services sector sub-sectors are hardly affected by the green transition, but **some key niches and subsectors will see a major impact** on jobs and skills, such as **finance, law, architecture, science, engineering and engineering to support the implementation of green policies** at national level. There are also several **emerging professions** in this field, such as e**nvironmental advisors and auditors with a green focus.** In these sub-sectors that will support the green transition, appropriate competences will be needed. This ranges from planning, development of "green" standards, to monitoring policy implementation and green procurement **[BE1]**. The public employment service of Flanders (VDAB) provides detailed information on specific occupations on its website. The list does not contain any of so-called 'green occupations', however it does analyses bottelneck professions, such as the ICT developer analyst. These finding are confirmed by the KU Leuven in their research on **the implications of the climate transition on employment, skills, and training in Belgium**. They expect significant transformation of at least four categories of jobs: • **Mobility managers** will have to link their initiatives not only to the corporate strategies but also to the local ecosystem of smart cities and by developing integrated apps interconnecting different transportation services • **(Chief) Data officers** will have to include in their IT choices the critical question of digital pollution and thus acquire new skills, not only in technical terms (data-centric) but also in managerial and strategic terms (value-centric). They should also be able to integrate sustainable data management and mobility plans for all workers • **Middle managers** will have to learn how to manage and coordinate hybrid teams and they will have to make important choices concerning on-site and remote activities, while at the same time creating a team spirit and pay attention to the work-life balance and the well-being of team members • **HR managers** are expected to play an important role in the implementation of sustainable HRM policies through extended sourcing practices, training initiatives, renewed appraisal procedures and indicators, appropriate reward programs, etc. If the first category of jobs is still under development, the three others already concern several thousands of jobs and should continue to grow. They are also supposed to be at the forefront of the digital transformation of companies. Synthesis on skills due to the digital sustainability transition for these four categories:

	Mobility manager	Data Officer	Middle manager	HR manager
Effects on jobs & skills	• Implement integrated mobility policies according to national objectives • Make links with Smart Cities projects • Collaborate with IT to develop sustainable hybrid work (e.g. carpool applications)	• Integrate sustainable data management practices (production & stockage) • Optimize digital carbon footprint	• Manage hybrid teams (and hybrid meetings) • Manage the balance between onsite and remote activities • Develop new performance control practices • Manage the WLB and well-being of remote workers	• Link news ways of working and sustainable management • Build HR KPIs leading towards sustainable mobility and work practices • Improve digital, job-related and soft skills
Effects on training	*Topics* • Systemic view on mobility *Policy recommendations* • Develop appropriate initiatives in executive education • Encourage companies to create communities of practices on this topic	*Topics* • Digital sobriety *Policy recommendations* • Develop appropriate modules in bachelor and master studies in ICT • Develop digital sobriety certificates in partnership with employer associations	*Topics* • Hybrid management *Policy recommendations* • Support knowledge sharing on technical and organizational devices to manage hybrid meetings • Develop appropriate initiatives in executive education	*Topics* • Sustainable HRM *Policy recommendations* • Develop appropriate modules in bachelor and master studies in HRM • Co-develop sensitization initiatives with HR professional associations

They recommend for governments to develop a clear vision about training initiatives and plan ahead. Setting a clear training path, even extremely ambitious, is the first necessity. However, public authorities must be pragmatic and accept that new contextual elements can emerge. Between long-term vision about the climate transition and the concrete reality of today's workers and citizens, one needs to develop a capacity to "zoom in and zoom out" and a real prospective approach **[BE2]**

In the **Flemish Reform Programme**, it is observed that Flanders holds many levers (policies and investments) to help achieve the SDGs. The Government of Flanders uses a transition management approach to realise its ambitions. The seven transition priorities are: (1) Circular Economy: switch to the circular economy, (2) Living, Learning and Working in 2050: transforming the way we live, learn and work, (3) Industry 4.0: aims to **digitally transform industry as a lever for sustainability, competitiveness and productivity** of industry, (4) Living Together in 2050: **digital transformation of the cultural sector and the future of the care model**, (5) Mobility: the Flemish Mobility Vision 2040 as a basis for future mobility policy, (6) Energy and Climate: **energy and climate transition** in implementation of the Flemish Energy and Climate Plan (VEKP), and (7) Environment and Spatial Development for the Future: working on a spatial transformation and addressing climate adaptation and biodiversity challenges **[BE3]**.

Furthermore, a High Committee for a Just Transition, made up of 24 experts specialising in social issues, economics, democratic innovation and environment issues, aimed to share their expertise and advise the government and stakeholders. In 2023, the Committee submitted its report "**Just Transition in Belgium: Concepts, Issues at Stake, and Policy Levers**", framing just transition as 'a transformation of the economy, the state and society as a whole, in an age of ageing, digitalisation and changing geopolitical relations. It is about systemic changes that will take shape

	through uncertain times'. In their extensive report, the experts describe how to organise and institutionalise this just transition in Belgium, including a systematic analysis of the links between social and ecological challenges **[BE4]**.
Bulgaria	The highest unemployment rate in Bulgaria is present among persons that have a primary or lower education. The number of available IT jobs will soon exceed the number of IT graduates, only 2,3% of the employees in Bulgaria are employed in the ICT sector. Bulgaria does have difficulties with the uptake of new technologies and the development of innovative potential. There is need for green skills in curricula in formal education and awareness of the importance of green innovation needs to be increased among businesses. In Bulgaria, the focus is on the **digital transformation** of the country. Bulgaria has a respected and highly qualified pool of IT specialists meeting the business needs of this Silicon Valley of Southeast Europe. However, the Bulgarian education system has not kept up with demand and the number of available IT jobs will soon exceed the number of IT graduates, estimated at three times greater than what educational institutions can supply. On the positive side, the number of STEM (science, technology, engineering, and mathematics) graduates has slightly increased. According to Eurostat, 70,000 people are employed in the ICT sector in Bulgaria, which is 2.3 percent of the total number of employees in the country. This is below the EU average of 3.5 percent. The Ministry of Transport and Communications (Ministry of E-Governance) published a national strategic document "Digital Transformation of Bulgaria for the period 2020-2030". The strategy aims to integrate technological subjects and digital skills into the curricula of all levels of education and vocational training and retraining systems **[BG1][BG2]**. The availability of STEM (Science, Technology, Engineering, and Mathematics) subjects is perceived as a major challenge for Bulgaria's sourcing sector, largely due to the population's below-average digital literacy despite a relatively abundant number of qualified IT specialists. A positive trend is emerging in the swift establishment of 240 STEM centres in primary and secondary educational institutions countrywide, encompassing even small towns and villages. This initiative is part of the EU's Recovery and Resilience Plan, signifying a strategic effort to bolster STEM education at the school level. At the same time, the Green Restart Coalition (an initiative from MOVE.BG, WWF Bulgaria, Greenpeace Bulgaria, Institute for Circular Economy), tries to redirect the focus to sustainability describing over 150 challenges identified in relation to **the country's sustainable development**, together with **more than 150 specific ideas** on how to overcome them in their report "Mission Green Bulgaria: How to Turn Bulgaria

	into a Green and Innovative Leader". A total of 54 leading Bulgarian experts in the fields of **innovative economy and science, energy transition, bioeconomy and biomass, smart cities and circular practices in urban environments, biodiversity and sustainable finance** generated these challenges and recommendations. The experts observe that in general, Bulgaria faces substantial **difficulties in the uptake of new technologies and the development of the innovative potential**. It ranks 26th in the EU in terms of the integration of digital technologies in business and society according to the EC's Digital Economy and Society Index (DESI 2021) and it scores last but one in terms of innovation performance in the Community according to the EC comparative analysis EU Innovation Scoreboard. Bulgaria has the lowest score of the EU Eco-Innovation Index 2021 which measures the eco-innovation performance of businesses, society and the public administration, as well as its development and support on the level of research, business and government. The difficulties reported for Bulgaria are the weak and almost missing penetration of circular economy practices in production, the unreformed structure of the economy which needs urgent and rapid green transformation, and the low levels of state budget resources allocated for research and development (R&D) activities. With respect to green innovation, the experts see the following education and information challenges: • **Lack of green skills curricula in formal education,** both in secondary and tertiary education • **Lack of awareness of the advantages** resulting from the introduction of green innovation among conventional businesses that do not recognize the importance of the uptake of green innovation and its impact on competitiveness or the need for investment in the creation and development of green innovation • **Insufficient integration of Bulgaria in the networks of the European Institute of Innovation & Technology (EIT)** **[BG3]**. In their "Bulgaria's Future History Textbook" the Coalition outlines the process of change by 2050, if today Bulgaria start introducing specific reforms and design with an intelligent and long-term vision the National Recovery and Resilience Plan (NRRP) through which the country will receive additional 12 billion from the European Union recovery mechanism "Next Generation EU". In this report they propose long-term integral measures for overcoming the digital gap and developing green competencies, presenting **more than 40 ideas in support of the innovation ecosystem**, sent to the Bulgarian authorities in charge of the preparation of the NRRP. Measures in this area are very important, with Bulgaria being 'the most resource, energy, and greenhouse gas emission-intensive economy in the EU, with important investment needs in the fields of energy and decarbonisation to facilitate the

	transition to climate neutrality' (European Commission in the 2020 Spring European Semester at the establishment of the "Next Generation EU") **[BG4]**.
Croatia	By integrating digital skills and sustainable development practices, the Croatian labour market is reshaped, workers are needed to adapt to new technologies and sustainable practices. It is important to keep up with the pace of technological advancements, skills need to be matched accordingly, mismatching could lead to higher unemployment rates. The Croatian government has developed several strategic frameworks aimed at digitalisation and enhancing sustainability within the labour market. Key among these are the National Development Strategy 2030 and the Digital Croatia Strategy until 2032. The **National Development Strategy** targets a holistic approach to digital and green transitions. It aims to elevate Croatia's ranking on the EU's Digital Economy and Society Index (DESI) by improving digital literacy and fostering sustainable business practices across all sectors of society. This comprehensive development includes enhancing the digital infrastructure, promoting green jobs, and supporting the digital transition of the Croatian economy **[HR1]**. The **Digital Croatia Strategy until 2032** focuses on digitalisation of Croatian society, including the public administration and the economy. The strategy's goals are to increase the number of ICT specialists, enhance digital competencies across all demographics, and ensure the integration of digital technologies in educational and professional settings **[HR2]**. Croatia has implemented a system of vouchers for developing green and digital skills investment that aims to increase the employability of workers and better match labour market supply and demand by supporting lifelong learning and the acquisition of new skills, particularly green and digital skills. Vouchers are used by both employed and unemployed people, although a particular focus is placed on vulnerable groups (long-term unemployed, inactive or young people not in employment or education). There are also adjustments in educational curricula to include more intensive digital and ecological training. **[HR3]**. Croatia faces structural challenges that could impact the implementation of the strategies: • rapid technological change, requiring continuous policy updates and educational adjustments • skill mismatch, where the skills of the available workforce do not align with job market demands, which may lead to to higher unemployment rates among certain demographics unless addressed through targeted training programs • integration of digital technologies, poses both a challenge and an opportunity, ensuring that the entire workforce can adapt to these changes is crucial for inclusive growth. In 2022, The World Bank published a report on **Smart Skills** in Croatia, describing these challenges and also some opportunities, considering **the green**

	transition a key pillar of the recovery strategy. On international markets, greener products are also a possible niche for Croatia to meet increasingly exacting standards for sustainable resourcing. Whereas green skills are essential for building back Croatia's economy in better, more sustainable, and resilient ways, green talent growth appears to be increasing comparatively slowly. **Targeted investment in education** to increase development and quality of specialized skills is needed but must be combined with short- to medium term skill upgrading initiatives **[HR4]**.
Estonia	For Estonia to be able to transition towards a sustainable and green economy, some digital sustainability skills are needed. These skills include, understanding of AI and data analytics, Building Information Modeling (BIM) technology, 3D modelling, smart grid technologies and renewable energy IT solutions, renewable energy technologies and energy efficiency, energy conversion and storage technologies, sustainable building practice and environmental impact assessment, environmental engineering, maintenance and repair of hybrid, gas and electric vehicles, sustainable logistics and transportation planning, precision agriculture technologies, environmental research and application of green technologies. Besides these digital sustainability skills, also other green/ environmental skills are needed as well. In Estonia, OSKA forecasts the need for Estonian labour force and skills. OSKA studies are conducted by the Estonian Qualifications Authority (Kutsekoda) and are focused on current employment and forecasts in different sectors. In 2021 OSKA publised a report on the **skills necessary for green and digital transition**, outlining essential skills necessary for Estonia's transition towards a sustainable and green economy, emphasizing both general and sector-specific competencies **[EE1]**. The analysis highlights the fact that the digital and the green transitions are inevitably linked, as the development of, and investment in, digital technologies creates the preconditions for the green transition. Technological skills need to be combined with the ability to understand natural processes, and sector-specific green skills are increasingly becoming a mandatory part of professional skills **[EE2]**. **General digital skills** for the transition listed are: • basic digital skills • secure communication skills and • data analysis and visualisation. The report also addresses several **sector-specific digital skills** related to: • accountancy, • public administration, • construction (e.g. BIM), • energy (e.g. smart grid technologies, renewable energy IT solutions, automation and data-driven energy management systems), • ICT (e.g. comprehensive knowledge of software development, communication technologies, and cybersecurity and proficiency in data analytics, AI, and IoT), • finance, • education (e.g. digital learning environments and virtual reality) and **skills for the green transition** related to: • energy and mining (e.g. renewable energy technologies

	and energy efficiency), • construction (e.g. environmental impact assessment), • chemical, rubber, plastic, and building materials industry • water and waste management (e.g. environmental engineering and sustainable waste management), • transport and logistics (e.g. sustainable logistics and transportation planning), • forestry and agriculture (e.g. sustainable forestry management and precision agriculture technologies to enhance productivity and reduce environmental impact) • mechanical and metal industry, electronics • real estate services (e.g. management of energy-efficient buildings and sustainable maintenance practices) • creative industries • education and research (e.g. knowledge and consultancy for the green transition, environmental research and application of green technologies), • public administration (e.g. sustainable planning and environmental management and • finance (e.g. green investments and sustainability reporting) **[EE1]**. Another OSKA study on the "Future Outlook on Workforce and Skills Needs in the Information and Communication Technology Sector" emphasises the significant impact of the green transition on the IT sector, indicating a heightened demand for professionals skilled in crafting environmentally sustainable solutions and refining existing systems for enhanced sustainability and efficiency, highlighting varying impacts across different occupations, with roles such as **software analysts, ICT systems analysts, cybersecurity specialists, testers, and data analysts** projected to experience growth in employment. Conversely, certain positions such as **IT managers** are expected to see only marginal employment growth **[EE3]**. Currently, Estonia aims to build the greenest digital government in the world, using AI, cloud infrastructure and more to reduce the environmental footprint of digital government and develop climate- and environmentally friendly IT solutions **[EE4]**. This is outlined in Estonia's Digital Agenda 2030 **[EE5]**.
France	In France, the focus is mainly on the eco-design of digital services. There is a legislative framework that has been taking shape since 2021 and should enable the eco-design of digital services to take hold over the next few years. There are currently 2 main laws: the Anti-Waste and Circular Economy Law, the AGEC law (Anti-Gaspillage pour une Économie Circulaire) and the 2021 law aimed at reducing the digital sector's environmental footprint, the REEN law (Réduction de l'Empreinte Environnementale du Numérique). The REEN law prescribes for example, the need to train engineering students in digital-related courses in the eco-design of digital services and the need to raise awareness of digital sobriety from an early age. However, the subject is still struggling to establish itself, or even to take precise shape within organisations **[FR1]**. These laws are supported by government roadmaps and initiatives, such as the International Digital Strategy, a comprehensive framework

	aimed at promoting a digital world that is open, diversified, and trustworthy **[FR2][FR3]** and the Roadmap on the Environment and Digital Technology, describing 50 measures for a French and European agenda on responsible digital technologies: sustainable and at the service of the ecological transition and of the sustainable development goals **[FR4]**. The Observatoire des métiers du numérique, de l'ingénierie, du conseil et de l'évènement (OPIIEC) has set out to identify the skills, employment and training needs of companies in in terms of the environmental footprint of digital technology. A number of "new" professions are emerging within larger organizations: • **Responsible Digital Manager** (provides expertise and acts as an interface between the IT Department, the CSR Department and the General Management, creating value through responsible design of digital products and services), • **Sustainable Development Director** (oversees an organisation's sustainable development impacts, activities and aspirations, supervising project managers and heads of responsible departments), • **Carbon auditor** (takes "exhaustive photographs" of all the GHG emissions of a particular organization, event or project, facilitating decision-making in terms of actions to be taken to reduce carbon impact), • **Responsible Digital Trainer** (provides expertise and support to Green IT managers, responsible for raising awareness and training internal teams). OPIIEC notes that these new professions tend to be reserved for larger companies, while in smaller companies, these functions are often integrated into general management, or even technical management. The study also identifies a series of key skills directly linked to technical aspects in terms of hardware, software and network/ cloud. Another conclusion of the report is that some engineering schools and universities offer modules on the subject, but that the subject is unfortunately only touched on in the majority of training courses and that this training offer is insufficient in number, unclear and ill-adapted **[FR5][FR6]**. Atlas is an organisation that supports professional sectors, companies and employees in their training needs, work-study recruitment and work-study programs. Based on an extensive projected impact analysis by sector, ATLAS describes in their report Green Transition in detail **the impact of sustainability on 8 sectors and on the 61 main professions** in those sectors; insurance, banking, consulting, events, accountancy & auditing, finance, engineering and ICT. In a series of detailed charts, they show **the need for specialists and their additional competences per sector**. The document contains a large amount of very detailed and valuable information that is too extensive to list it all here **[FR7]**. In a summary of the report, they outline **12 proposals for multi-sector training** to support the sustainability transition on a large scale in France: • IT eco-design (experts), • IT eco-

	thinking (all professionals), • Office eco-mindsets (all professionals), • Environmental risk analysis (financial services), • Global risk analysis (e.g. insurance), • Corporate Sustainability Reporting Directive (CSRD) (e.g. accountancy & auditing), • Environmental data science (e.g. consulting), • Environmental footprint measurement (all professionals), • Eco-design (e.g. event management), • Economic and legal risks of ecological transition (e.g. finance), • Transposing the risks of ecological transition into insurance, banking and financial risks (financial services), • Environmental management control (e.g. consultancy) **[FR8][FR9]**.
Germany	Overall, Germany performs well in the area of digital and green skills, but there is still room for improvements. Germany is one of the global leaders in green technologies and sustainable development and is the most important country for patents in the field of clean and sustainable innovation in the European Union. It has put sustainability high on its political agenda. Germany's **Sustainable Development Strategy**, aligned with the UN sustainable development goals, promotes economic development that is socially viable and ecological **[GE1]**. Public and private R&D spending in Germany exceeds 3% of GDP, which is among the highest R&D intensities in Europe. Green jobs and skills have seen a significant rise in Germany and various industries, including **solar and wind energy**, **climate tech**, **waste management**, and **sustainable agriculture**, are seeking skilled and dedicated workers. Germany is leading in climate tech and waste management and recycling. In its **2024 Empoyment Outlook**, the OECD states that "in Germany, 21.1 percent of the workforce is employed in green-driven occupations," which include jobs that "do not directly contribute to emission reduction but are likely to be in demand because they support green activities". There is still, however, a huge room for improvement in the area of digital skills. According to the Digital Econo The government laid out its ESG-related objectives for the next 30 years in a comprehensive study, the National Clean Development Strategy, as early as 2020 my and Society Index (DESI) 2022, Germany is ranked 16th amongst the 27 participating EU states, with a score of 45 compared to the average EU 45.7 **[GE2][GE3][GE4]**. The Federal Government of Germany adopted the **Digital Strategy 2025**, aiming to improve the framework conditions for the progress of digitisation in all areas **[GE5]**. Education and training face challenges in keeping up with the rising demand for green skills. There is a lack of enough green skills education and training, particularly in regions under high pressure to transform the number of trainees in occupations with green skills increased more slowly from 2013 to 2021 than in other regions. Hence,

	the ecological transformation of the vocational training system proceeds more slowly in regions with high pressure to transform **[GE5]**.
Hungary	Hungary heavily relies on fossil fuels and falls behind the EU average in terms of ESG performance. The Hungarian ESG law adopted on December 12, 2023, is expected to have significant impacts on the labor market and the education system. The law aims to promote sustainable economic development and encourage companies to incorporate environmental, social, and governance (ESG) considerations into their operations. The new law has made it mandatory for companies to report their sustainability practices, this means more transparency in the supply chain. This results in **more data** that is needed to be collected, and some companies might not have the right competences available at this moment. This means that there will be an increased demand for employees with **ESG-related skills, there will be a need for training for existing employees, more jobs will become available in the renewable energy industry** and **there is already a strong emergence of ESG advisory services in the consulting market**. It is also expected that sector-specific knowledge will soon be required in Hungary in industries such as the hydrocarbon industry (oil and gas extraction, refining), heavy industry (metallurgy, cement production), the chemical industry (fertilizer production, battery manufacturing), and construction. Universities will also present more digital sustainability related programmes such as **environmental technology**, for this, teacher training materials need to be reviewed and updated with the latest technological trends to be able to stay in line with market requirements. The government laid out its ESG-related objectives for the next 30 years in a comprehensive study, the **National Clean Development Strategy**, as early as 2020. Hungary boasts outstanding conditions for renewable energy production, particularly in solar and geothermal energy utilization. It is a country rich in freshwater resources relative to its size. Hungary actively participates in achieving the EU's climate policy objectives. Unfortunately, Hungary still heavily relies on fossil fuels, posing a significant environmental burden. Hungary also lags behind in energy efficiency compared to other countries in the region. Environmental and social responsibility among Hungarian companies and workers is still insufficient **[HU1]**. The **National Digitalisation Strategy 2022-2030** was approved in 2022. It aims to provide 95% of households with gigabit networks, to increase digital skills of the population, to support digitalisation of business processes, and to increase the use of e-government services. A whole section in this report is dedicated to sustainable development areas, providing a sectoral breakdown (• water, • waste management, • agriculture, • environmental monitoring, emergency response, climate risk, and • IT

	and cyber security) of the points that contribute to achieving sustainable development goals through digitalisation **[HU2]**. In Hungary, **adult education** is defined by law and its related implementing regulations. Despite the strict accreditation process and reporting system, **ESG-related courses** are proliferating, with new programs being introduced weekly. These new courses prepare students for ESG-related jobs by typically encompassing ESG principles, development and implementation of ESG strategies, measurement and reporting of ESG performance, and ESG risk management. An important goal in higher education is to supplement existing curricula with ESG-related content. Numerous Hungarian higher education institutions already offer sustainability and ESG-related courses, like Corvinus University of Budapest and Budapest University of Technology and Economics.
Ireland	Irish businesses are facing increasing pressure to mitigate the impacts of their business and operations on the environment and climate change. To meet the evolving demands of the twin transition, educational institutions, training providers and industry collaborations play a crucial role in preparing a skilled workforce. By addressing the skills demand highlighted in labour market reports, Ireland can capitalise on the opportunities presented. In their 2024 report on **Measuring "green" jobs in the Republic of Ireland**, the Irish Economic Research Institute, NEVIM, estimated EGSS (Environmental Goods & Services Sector) jobs at 41,836 in the Republic of Ireland in 2020. The report indicates that the highest proportion of these EGSS occupations are in the **manufacturing and industry sectors** at 31,288 jobs. **Agricultural and services** EGSS jobs are estimated at 3,754 and 7,279 respectively **[IE1]**. In terms of the digital landscape, according to the IDA 106,000 people are employed in the ICT industry. Ireland is now home to 16 of the 20 largest global tech companies, along with three of the largest enterprise software providers in the world in IBM, SAP and Oracle. The EU's Digital Economy and Society Index (DESI) 2023 shows Ireland holds a leading position in the EU in terms of SMEs with at least a basic level of digital intensity (currently at 85% versus the target of 90%) **[IE2]**. The National Skills Bulletin 2023 notes that the impact of the green agenda (sustainability) means that as industries in Ireland address issues such as **sustainable sourcing, circular lifecycles, energy efficiency,** and **waste minimization,** the skills mix of the workforce will also need to evolve, with a continued strong demand for **scientists and engineers** in order to fully implement these changes **[IE3]**. The twin transition towards sustainability and digitalisation presents **both challenges and opportunities** for Ireland's labour market. The Irish government set targets for

	national objectives, aiming to halve greenhouse gas emissions by 2030 and achieve net-zero emissions by no later than 2050. The National Climate Plan 2023 outlines that **higher and further education and training** provision will fully meet the demand for the range of low carbon skills required across the economy. The plan also indicates that continuous horizon scanning will be necessary to identify employment opportunities arising from the green transition. This process involves mapping these opportunities to existing training programmes and determining where new training and educational courses are required to inform course development and training initiatives **[IE4]**. The Green Skills for FET 2021-2030 report suggests Ireland's future competitiveness will be increasingly linked to its ability to decarbonise, the FET (Further Education & Training) sector plays a crucial role in the green transformation of the economy and society, delivering the requisite skills **[IE5]**. Skillnet Ireland's report on Talent for Ireland's Green Economy 2022 acknowledges that the transition to a low-carbon economy requires structural change across sectors and occupations and intensified innovation efforts. In this context, skills gaps are increasingly recognised as a major obstacle in sectors closely linked to the 'green economy' **[IE6]**. According to Future Skills Challenges of Irish Business report (2024) Ireland's evolving economic landscape is undergoing rapid change and is also underpinned by the twin transitions of climate action and digitalisation. Businesses are facing difficulties in hiring employees with the required skills and expect that the core skills of existing employees will need to evolve in the next two to three years **[IE7]**. It is important to note that the majority of reports collated **do not specify roles / occupations** with regards to the twin transition; rather, they outline **essential skills**. The IKC3 report 2023 on Skills for Sustainability highlights the necessity for **ongoing research on skills needs** to pinpoint sector and profession-specific skills, with direct **consultation with industry groups** and their sector bodies **[IE8]**. The National Skills Council and The Expert Group on Future Skills Needs have undertaken comprehensive work in highlighting a wide range of skills required from learning providers, both FET and HE, in three specific sectors: • Renewable Energy; • Retrofit; and • Electric Vehicles. The Expert Group on Future Skill Need's Skills for Zero Carbon report (2021) details how the transition to a zero-carbon economy will lead to changes in sectors and occupations, the phasing out of existing roles, but also demands for new skills and competencies, as well as employment opportunities. Consistent demand will be created across engineering, environmental, science and humanities and legal/professional roles, as well as in construction, retrofit, transport and logistics and electric vehicle maintenance. There are dependencies between addressing digitalisation and transitioning to a zero carbon economy, particularly

	with respect to **renewable electricity generation** and **"smart" systems design.** To deliver on the Climate Action Plan targets, employment in these areas will have to quickly increase **[IE9]**. The National Skills Bulletin 2023 highlights the growing need for professionals with expertise in digitalisation and sustainability. It identifies digital skills as a priority area, with particular demand for **software development, data analytics, cybersecurity,** and **digital marketing**. The twin transition further accentuates the need for **skills in IoT, AI, cloud computing**, and **data science [IE3]**. The Future Skills Challenges of Irish Business report (2024), indicates that 59% of businesses highlighted that their staff **require upskilling** in climate action and sustainability skills. 64% of all businesses consider **energy efficiency** to have the potential to facilitate growth in the next two to three years. 49% of SMEs regard climate action and sustainability as a very important skills area in terms of growing their business. 70% of large businesses see **green marketing and sustainable supply chain skills** as key. The report identified the following climate action and sustainability skills for business growth in the coming years (from hightest potential 64% to least potential 29%): • **Energy efficiency • Innovation & creativity • Policy & regulation • Green marketing • Sustainable supply chains • Circular economy • Environmental accounting • Environmental PM • Sustainability engagement • Environmental science [IE7]**. The Skills for Zero Carbon 2021 report offers a more detailed overview on core environment, science and humanities occupations. This category includes planners, environmental scientists, ecologists and social scientists, as well as highly specialised technical experts within these occupations. **Environmental impact assessments** in particular, which are regularly required for wind farm developments, need input from a range of specialist experts **[IE9]**. The National Skills Bulletin 2022 stated that the transition to a zero carbon economy has significant implications for **construction related skills**, from **green buildings** to **renewable energy** generation; while a small number of relatively new occupations are likely to grow in size, the most significant impact will be **changes in the skills mix of a range of existing occupations** as well as an increased demand for some **[IE10]**. **Microsoft's** Sustainability Transformation 2022 report notably calls out the fact that one in five Irish businesses have not started their sustainability journey, three in five businesses do not have a dedicated sustainability strategy and seven in ten businesses did not have someone tasked with developing and implementing a sustainability strategy. However, four in five (81%) businesses believe digital technologies are important in accelerating their sustainability transition. Only two in

	five businesses having formulated a dedicated Sustainability Policy or Strategy. On a positive note, the study identified that of those organisations who are embracing digital technologies for sustainability efforts, three in ten businesses (29%) reported using digital technology for reducing carbon emissions. Over a third (36%) reported using digital technology for increasing energy or fuel efficiency **[IE11]**.
Italy	According to several EU-wide metrics, the level of digitalisation of Italian Micro-enterprises (MEs) and SMEs is lower than in other European countries . Italy ranks 18th out of 28 countries in the 2022 EU Digital Economy and Society Index (DESI). About 40% of Italian companies seem to have made modest investments in digital technologies and training or reskilling. In 2023 small and medium-sized enterprises are still lagging behind in specialised digitisation activities. In 2023 60.7% of SMEs will adopt at least 4 digital activities out of the 12 used to compose the Digital Intensity Index (57.7% in the EU). At the same time, among companies with at least 10 employees, cloud computing (61.4%, 45.2% EU average) and electronic invoicing, which is required in Italy by law (97.5%, 38.6% EU average) are confirmed as leading indicators compared to EU companies **[IT1][IT2][IT3].** Italian gorenment has made the digital transition one of its two central pillars to bolster its economy, together with the green transition. Specifically, in the Italian case, twin transition is the cornerstone around which the programming resources 2021-2027 plan will focus at national and regional scales, with a focus on 12 Thematic **Areas and their Strategic Objectives,** among which Research & Innovation, Digitalisation, Energy, Environment and Natural Resources, Transport & Mobility, Urban renewal, and Social & Health **[IT4][IT5][IT6]**. Two concrete policy instruments are used for implementing twin transition in Italian regions: Recovery-Fund Financial Resources (PNRR) and the Regional Operational Program (ERDF). The PNRR is structured in missions (M) and components (C) and is managed (concretely) at national, regional, or sub-regional levels. Interventions imply the promotion of digitisation and ecological transition both in the public and private sectors, fostering systemic innovations in regulatory processes and businesses' value chains. The **regional Smart Specialisation Strategy (3S)** constitute a regional policy orientation document to convey ERDF regional resources, setting different innovation targets for each region, aligned with the **national S3**. For example, the S3 of the **Lombardy region** focus - with a view to smart, integrated, and sustainable development - on the distinctive sectors of regions with a high rate of

	industrialisation and a strong manufacturing vocation (Aerospace, Automotive, Agribusiness, Eco-industry, Mechatronics, Advanced Manufacturing, Services, etc.). The S3 2021-27 of the **Piedmont region** include 5 priority areas of innovation: • Aerospace • Mobility (automotive supply chain, including reskilling and MaaS concept) • Advanced manufacturing (digitisation and ecological transition, towards positive products with a social impact • Technologies, resources, green materials (focused on the environmental sustainability of production processes) • Food (food value chain, as a fundamental driver addressing sustainability and climate change) **[IT7].** Despite their heterogeneity, the most industrialised Italian regions share a common need for solutions to unlock their sustainable digital transition: Lombardy, Piedmont and Valle D'Aosta, Trentino Alto Adige, Campania, Sardinia. These regions cover approximately 40% of the national GDP. Istat details this further in their report on **Sustainable Business Practices in 2022 and Outlook 2023-2025 [IT8]**. **Lombardy** has the highest number of enterprises in Italy . One of the strategic objectives of this region is the transition to sustainable development and growth, promoting conscious use of energy resources and the use of renewable sources, directing investments towards new technologies in support of energy efficiency projects, in particular of public and private buildings and sustainable multimodal mobility, including the improvement of air quality. At the same time, **Assintel's 2021** report depicts several weaknesses: a lack of skills, comprehension and vision of the most challenging technologies, difficulty finding funds, lack of know-how, green and business sustainability plans for the emerging technologies, and problems activating collaborations with universities and research centres **[IT1]**. Regarding the 2021 regional DESI index, the **Piedmont region** ranks among the highest-scoring areas in Italy in scores such as basic digital skills, use of ICT services, etc. Both fixed and wireless Internet connectivity is highly available. According to a 2022 paper on the Piedmont SMEs' digitalization process, the region's incidence of digital-intensive production sectors is higher than the Italian average: 31.8% compared to 26%. However, the percentage of companies with IT skilled personnel is low, around 17,8%, similar to the Italian average of 16.4%. The Piedmont work environment is deifferent in comparison to the other Italian regions: (i) the work market is less dynamic for the digitally skilled workforce; (ii) companies are looking

	for digital professionals with a focus on digital technologies applied to manufacturing; (iii) the number of graduate ICT students is low. Local companies are investing in digital technologies and innovative ICT solutions. In particular, investments in cloud computing and related services are constantly growing **[IT9][IT10]**. The production structure of the **Trentino region** is characterised by a substantial prevalence of service companies (73%) over industrial (27%) . According to the 2021 regional DESI , the Trentino region is in first place overall for digitisation among the Regions and Autonomous Provinces in Italy, obtaining a ranking of 57.5 (compared to the Italian average, equal to 50). Innovation – and in particular digitalisation – is one of the focuses for the Trentino companies that are also empowering their workers to face this complex process. Training activities aimed at innovation are significant, involving 29.7% of businesses. Regarding research and development activities, 24 per cent of companies have done it internally, while nearly 9 out of 100 companies have acquired R&D services externally. Obstacles registered in SME digitalisation are generally present, such as resistance to change, lack of knowledge and internal skills. An essential role in growth and employment is played by enabling technologies. Sustainability is the other focus for growth in Trentino, which needs organisational and productive changes, innovative services and new skills to align with the Green Deal principles. The number of companies investing is set to rise from 36% in 2020 to 56% at the end of 2024 **[IT11]**. The production structure of the **Campania region** is characterised by a substantial prevalence of service companies (73%) over industrial (27%). According to the 2021 regional DESI , the Campania region is ranked third for digitalisation in Southern Italy, with a ranking of 44.9, while the Italian average is equal to 50. The 2018 census data show that Campania companies have launched many actions in environmental sustainability, social responsibility and safety. In particular, 69.7% of companies with at least three employees act to reduce environmental impact. The sustainable behaviour of companies grows with increasing size. Still, Campania SME's are the most focused on improving well-being in the workplace and reducing environmental impact.

	Companies in **Southern Italy and the islands** are focusing on introducing new forms of automation in operations and much less on redesigning the business model. This trend could cause a delay in the innovation of the internal processes that the companies of this area feel to fill. According to the Assintel report 2020, 16.6% of ICT expenditure will be generated by the South and the Islands Regions. The Campania region is among the subjects that will have the most significant impact on the result **[IT12]**.
Nether-lands	The Netherlands are facing labour market shortages in engineering and ICT. The government is committed to address this, particularly in the light of the climate and digital transition and formulated **The Green and Digital Jobs Action Plan** in 2023. For the transitions, the cabinet mentioned two firm ambitions: Making the Netherlands climate-neutral by 2050 at the latest, and remaining among the leaders in the European Digital Economy and Society Index (DESI). The success of these transitions depends on having enough well-trained people. This requires additional action and cooperation from many different parties: employers, employees, education and governments **[NL1][NL2]**. The 2022 **Digital Economy Strategy**, integrates opportunities for sustainability **[NL3]**, referring also to the **Sustainable Digitalisation Manifesto**, by the National Coalition on Sustainable Digitalisation (NCDD), looking primarily at the environmental impact of the digital system. This document reports a list of bottlenecks with recommendations; a major bottleneck is the labour market shortage. The NCDD advocates that energy and digital systems should be integrated more and that international standards for sustainability monitoring, like carbon footprint, should be adopted. Furthermore, they argue for more knowledge and capacity building, as there is **a shortage of staff with relevant skills**, such as **improving the sustainability mindset in the procurement process** for hardware or adopting international standards for measuring software development or the material footprint of digital infrastructure **[NL4]**. Both **behaviour change** and **increasing staff's knowledge (awareness)** would help with the alignment of digital and sustainable goals of organizations. Furthermore, decision-makers from IT departments are slightly more inclined to seek collaboration with staff responsible for sustainability when it comes to exploring and improving the sustainability of the IT infrastructure used by their organisation **[NL5]**. The 2023, the Social-Economic Council (SER) report **More sustainable through digitalisation** is a policy follow-up on this. The aim of this study is to provide insight into the impact of digitalisation on environmental issues and sustainable development and to identify policy measures that can contribute to emission reduction and energy saving **[NL6]**.

	The **Dutch Digitalisation Strategy** (DDS) 2021 report identified challenges and issues for different sectors. Important observations are: • Digitalisation in the form of data analyses for agriculture and nature will play an important role in sustainable agriculture and in strengthening the biodiversity and nature • AI applications are seen as important for helping to reduce energy costs and improve the efficiency and sustainability of production • Services must be user-friendly, accessible, and understandable to remain inclusive for people. The collection and use of data can contribute significantly to addressing the sustainability challenge that also faces the Netherlands **[NL7]**. The DDS brings together all policies on digitalisation from the Dutch central government. Among other things, the DDS stresses the importance of an inclusive digital transition in which everyone takes part and it singles out the Netherlands' position as a digital frontrunner in Europe and the world. The DDS is acompanied by a **2030 Outlook Digitalisation**, envisioning different trends towards the future and describing their impact on different elements of the technlogy stack, not necessarily strictly related to the Netherlands **[NL8]**.
Romania	Since its EU accession in 2007, Romania's economy has more than doubled, leading to increased labour demand. At the same time, integration into the EU single market led to agglomeration effects, resulting in development concentration in certain regions/counties and high regional disparities. High emigration is one of the main causes for the current labour deficit in the country, as 70% of Romanian emigrants represented active labour force aged between 15-44 years. But also, the aging population will lead to a decrease in the number of young people in the labor market. At the same time, the demand for highly skilled personnel will continue to grow as the economy develops. By 2030, Romania will need over 600,000 specialists for highly skilled jobs, while universities will only be able to provide 40,000 graduates per year. At the same time, the demand for low- and medium-skilled personnel will sharply decline. Although the country has a high number of ICT graduates (ranked 4th), the shortage in ICT specialists limits the country's capacity to innovate and to reap the benefits of the digital transformation. By contrast, on female ICT specialists Romania ranks 3rd. Particular attention should be paid to the development of relevant skills, such as digital competencies, knowledge of foreign languages, and flexible and communicative skills (soft skills). This task requires close cooperation between the state, business, and the education system. To remain competitive, workers will have to retrain and acquire new skills relevant to the market. However, only 1% of Romanians aged 25–64 undergo professional training courses, and only 21% of companies invest in staff training. **[RO1][RO2]**.

	According to the International Trade Administration, The IT industry in Romania is experiencing constant development, and new trends are emerging year after year, making it one of the most significantly growing markets in the country. 2023 is a critical year for the technology sector in Romania, as the government has set forth several initiatives to help digitalize small and medium-sized enterprises. For example, the PNRR Digitalization of SMEs program is vital to this effort and could significantly impact the country's tech sector. The country's center point for IT development is the capital region of Bucharest (63% of nationwide revenue), followed by business centers in the North-West (18%); West (5%); Central (6%); and North-East 5(%). Romania is the leader in Europe and sixth in the world regarding the number of certified IT specialists per 1,000 inhabitants, larger than in the US or Russia. The Digital Agenda for Romania also sets priorities for crucial sectors for the Romanian economy and society: Employment, Research, and Development (R&D), Climate Change and Energy Sustainability, Education, and Fighting Poverty and Social Exclusion. There are nearly 192,000 developers in Romania as of 2023. The number of people pursuing a tech career is growing, since just a few years prior, in 2020, there were roughly 140,000 software engineers in the country **[RO3]**. The proportion of regulated professions that are knowledge-intensive and contribute creatively is quite close to the EU average. The **National Strategy for Sustainable Development of Romania 2030** (NSSD) adopted by the Romanian Government on 9 November 2018, sets forth the objectives and targets necessary to build a cohesive society that benefits from the improvement of the education and healthcare systems, the reduction of inequalities between men and women, and between urban and rural areas**.** The objectives of the NSSD are closely linked to the Sustainable Development Goals (SDGs) of the UN and structured around three pillars of sustainable development; economic, social, and environmental. These include: • Increasing economic competitiveness and productivity through innovation and investments in research and development • Increasing labour force participation and improving the quality of jobs • Reducing poverty and social exclusion • Improving access to quality public services • Promoting a circular and resource-efficient economy • Protecting the environment and combating climate change • Developing sustainable infrastructure and eco-friendly transportation • Promoting sustainable tourism and cultural heritage **[RO4]**. Besides the NSSD, there is also the **National Strategy for the Circular Economy in Romania**, to provide a roadmap to guide the country in its efforts to transition from a linear to a circular economic model **[RO5]**. Based on an extensive research, The World Bank, in cooperation with the Romanian Government, has developed an **occupational standard for the "Sustainable**

	Development Expert" (SDE) and published this in their 2023 report on Institutional Needs Assessment in the Field of Sustainable Development. In the report, they present the 'SD Competency model' and define a set of core competences and detailed skills descriptions for the SDE. Regarding **digital technologies** the report states that this "is identified as **a crucial training need**, however, from the perspective of an SDE's role; it cannot be an objective or role in itself but rather a means […]. From the perspective of SD competency, the use of digital technologies and data analysis skills belong to multiple competency areas. Therefore, training objectives for an SDE could be formulated in terms of 'how to use digital technologies to fulfill the main roles'. Furthermore, in relation to the mission of an SDE to contribute to the digital development of the community, reference is made to a specialised role and, naturally, to a distinct approach in terms of competency and skills. For instance, an SDE with a specialised focus on digitalisation within SD would have a specific competency such as **'Digital Sustainable Development**' and could have a crucial role in: **• Ensuring access to digital technologies and infrastructure in underserved communities • Promoting digital literacy and skills development for all individuals, including marginalized groups • Enhancing the use of digital solutions for efficient and transparent governance • Improving digital connectivity and access to affordable and reliable internet services • Harnessing the potential of emerging technologies, such as artificial intelligence and blockchain, for SD • Enhancing cybersecurity measures to protect digital systems and infrastructure in the community,** and so on. The competency required for an SDE with a digitalisation focus would encompass a mix of both SD competency and digital transformation competency and could be named as **Sustainable Development Digitalisation**. Training topics related to digital skills include: • Harnessing innovation and technology for sustainable development, particularly in addressing climate change and advancing circular economy practices • Integration of digital transformation initiatives within communities • Development of digital literacy, including modeling tools, data collection, visualization techniques, and • Geographic Information Systems (GIS) **[RO6].** This creates the possibility of (postgraduate) professional training related to this new occupation The report is available on the country's Sustainable Development Department together with other sustainability related materials, such as The Sustainable

	Development Goals book for little ones, raising awareness already at a very young age.
Slovenia	Currently there are 28.249 people employed in the digital sector. According to Eurostat data, 78% of enterprises had hard-to-fill vacancies for ICT specialists in Slovenia in 2021. It is estimated that at least 3.000 ICT specialist are needed in Slovenia and more intensive automation is needed to deepen the smart and green transformation processes in all parts of the economy. Despite the many studies available, there are no concrete and well-supported projections of the exact need for digital profiles. The deployment and use of more complex technologies remains a challenge, especially for micro, small and medium-sized enterprises (SMEs). Preliminary data on business maturity also point to a downturn in the implementation of Industry 4.0. Between 2018 and 2022, the share of companies showing high readiness even dropped from 26.3% to 24.4%. Lack of the right skills or staff is the most common problem companies face when digitally transforming their business. Furthermore, employment effects from digitalisation are strongest for private manufacturing firms **[SI1]**. It is noticeable that Slovenian companies rarely invest in skills themselves, as this must be done by the process owners. In March 2023, the government of Slovenia published a strategy report **Digital Slovenia 2030** and a **Strategy of Digital Transformation of the Economy**. The Strategy aims at a "balanced and innovative use of digital technologies in all segments of society and to provide opportunities for the greater inclusion of every citizen" and recognises that investments in digital technologies are needed and improving the digital competences of employees should be promoted, as should the strengthening of the ICT sector and the increase in the number of ICT professionals in Slovenia for the advancement of all sectors. It will be essential to reduce administrative barriers and harmonise legislation **[SI2]**. Furthermore, the digital transformation of Slovenia explicitly aims at digital inclusion, strengthening the participation of employees in companies, as well as communities and individuals and their involvement in all areas of social life. Digital social innovations will increase the social sustainability of business models. One of the main objectives is strengthening the knowledge and digital competences of ICT staff and developing and retaining talent in advanced digital technologies **[SI3]**. The **Slovenia 2024 Digital Decade Country Report** shows that Slovenia has made notable progress in e-government, including the implementation of the national e-ID scheme and achieving a high overall e-Health maturity and regarding connectivity infrastructure, Slovenia has a strong starting point in Fibre to the

	Premises (FTTP) coverage, with 78.5% of households covered, against an EU average of 64%. Slovenia falls below the EU average with regards to SMEs' basic level of digital intensity and Slovenia has a significant shortage of ICT specialists, with many enterprises facing recruitment difficulties, highlighting a critical gap in the digital labour market. An important recommendation is to strengthen the early identification of labour market needs and further complement them, especially in the area of digital upskilling and reskilling. Adapt the (higher) education curricula to the latest digital needs and address the gender gap. Strengthen collaboration between industries, (higher) education institutions, public administration and relevant stakeholders to increase the effectiveness of those measures **[SI4]**. The Institute of the Republic of Slovenia for VET has published two documents: A **Skills mapping guide in the field of sustainability and the mitigation of climate the change into professional standards,** describing work packages for the identification of sustainability skills and their mapping to professional standards, like procurement, waste management, health etc. **[SI5]** and **A set of competency frameworks for embedding sustainability and climate change mitigation knowledge and skills in occupational standards and education programmes [SI6].** In an **article on sustainable competences and skills**, the following aspectss are listed (among others): • Knowledge about megatrends, their purpose and how they can affect individuals, society and the economy • Experts who can calculate carbon footprints, plan a strategy for action across the supply chain, prepare complex ESG reports • Skills needed: Sustainable innovation, communication of sustainable values, ethical decision-making, environmental awareness and ecological thinking, understanding the principles of the circular economy, sustainable resource management, social responsibility, ability to think innovatively and to find new ways to achieve sustainability goals and to adapt to rapidly changing circumstances **[SI7]**.
Spain	According to the **OECD Employment Otlook**, (2024) the Spanish labour market continued to show strong dynamism, but unemployment remains high relative to the OECD average. The employment rate has reached record levels in over a decade, with 65.7% of working-age adults in employment in the first quarter of 2024. Almost one-in-five Spanish workers is employed in green-driven occupations, in line with the OECD average. However, only 11.5% of workers in this group are actually employed in "new and emerging green occupations", significantly below the OECD average (14.5%), whereas the rest are employed in jobs that are not new but that are linked to the green transition. Spain has been particularly active in promoting training for the green transition. The country provides funding for new training and apprenticeship

	programmes related to the green transition and is one of few OECD reporting to have career guidance initiatives to facilitate transition into green jobs **[ES1]**. At the beginning of June 2020, the Spanish Government published **España Circular 2030, the new Strategy for Circular Economy in Spain** until 2030. It contains circular economy objectives and a series of strategic orientations for the period 2020-2030 **[ES2]**. Other relevant reports are: **Sustainable Development Strategy 2030** **[ES3]**; **The Just Transition Strategy** (2020), which focuses on consolidating mechanisms to leave no one behind **[ES4]**; **The National Integrated Energy and Climate Plan** (2020), reinforcing the commitments to fight climate change **[ES5]**; **Digital Spain 2025** (2020) with its Digital Skills Plan **[ES6]** and the **Recovery, Transformation and Resilience Plan**, Spain's response to the Next Generation EU funds **[ES7]**. Forética, the leading organization for sustainability in Spain, presented the report **'Green Jobs and Fair Transition in the Future of Work'** as part of their 'JOBS 2030 – Future of Work' project. Within the framework of this project, Forética is building a Spanish **observatory on green employment and fair transition** with the aim of analysing the situation of green employment in Spanish companies, proposing ways forward and a roadmap with the main elements of action and highlighting the good practices of some leading organizations. In the report it is noted that the demand for green skills is growing at a rapid pace and workers need to be trained for it. By 2022, the talent mismatch in Spain has reached the highest level in history and 8 out of 10 companies are struggling to find the professionals they need. This is combined with a rapid growth in the supply of jobs in sectors closely linked to green jobs; the ranking of sectors leading green employment in Spain is: 1. Renewable energies 2. Waste management and treatment 3. Waste water treatment and purification 4. Organic agriculture and livestock farming 5. Sustainable forest management 6. Public sector activities based on monitoring compliance with regulations and legislation or environmental education initiatives **[ES8]**. Spains employment agency, AE, notes that the green economy in Spain generated more than half a million jobs in 2019, 2.5% of the total, and these figures are expected to increase significantly. Their report on **Emerging professional profiles** highlights 10 new professions with excellent employability prospects: • Occupational Risk Prevention, Quality, Environment and CSR Technician • Sustainable Technology Solutions and Projects Analyst • Sustainable Logistics Consultant • Eco designer • Circular Economy Specialist • Environmental Education Specialist • Environmental Sustainability Expert • Renewable Energy Expert • Environmental Engineer and • Cultural Manager specialising in Sustainability. Practically all of these require a university education, mainly in Science and Engineering degrees, and many require

	specialisation through postgraduate studies. 11 areas are highlighted that generate sustainable employment: • Administration and Management; • Environment and Safety; • Socio-cultural Services; • Commerce and Marketing; • Vehicle Transport and Maintenance; • Building and Civil Works; • Agriculture; • Extractive Industry; • IT and Communications; • Textile and Clothing and • Industry and Maintenance, with more than 30 new professional profiles in demand by Madrid's businesses. The training required is not always university education, although skills such as teamwork, leadership skills, empathy, environmental awareness, creativity, autonomy and business mentality are among the most sought-after. Finally, professional profiles include: • Sustainability and Circular Economy Director; • Sustainable and Circular Legislation Lawyer; • Feasibility and Sustainability Analysts; • Waste Recycling Operators; • Circular Economy Specialists; • Eco-entrepreneurs; • Environmental Researchers; • Sustainability Educators; • Environmental Consultants, as well as a large number of **technical professionals** in specialities such as: • sustainable finance; • renewable energies; • sustainable energy; • sustainable consumption; • environment; • waste management; • recycling and reuse; • electromobility; • sustainable communication; • sustainable digital platforms or • technicians in climate change, among others **[ES9].**

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D2.1.Annex.D analysis of the questionnaire

4.1 Approach

Besides desk research, the questionnaire was the other main technique to gather input on current demand. In addition, the questionnaire was also used to understand the expectations about what the future demand will be. Therefore, the main question to be answered by the questionnaire was: "What are the current and future roles and skill needs for digital for sustainability professionals in organisations that have a need for these professionals?". The questionnaire consisted mainly of multi-select questions, as well as ranking questions, questions with a Likert scale and some open questions. The implementation of the questionnaire basically consisted of three steps: selecting the sample, collecting the data and analysing the data.

The population of the questionnaire consisted of organisations in need of skilled digital for sustainability professionals. This is the starting point to find and select organisations for the sample. Given the generally low response rate to questionnaires, it was advised to add as many organisations as possible to the sample. The questionnaire was distributed using social media channels and the networks of the contributing partners of the consortium. The questionnaire was provided in English, and EU Survey was the online tool used to collect the data. The questionnaire can be found in the annex questionnaire.

Contributing partners were asked to aim for at least 30 respondents each. While this is not a large enough sample to draw statistical conclusions at the national level, it is large enough to give indications, while the sample size will be large enough at the European level.

The data were analysed using several techniques. In addition to descriptive statistics, to describe the characteristics of the sample, it was checked whether moderating variables (such as type of organisation, organisation size, etc.) affect the results of the questionnaire. Other inferential tests, such as correlation tests and regression tests, were not considered relevant given the nature and purpose of the questionnaire as part of a multi-method approach. The questionnaire served as one of the inputs for determining the current and future skills demand for digital sustainability professionals, and no hypothesis testing was intended.

4.2 Results

The questionnaire was distributed by consortium partners via social media, emails, and personal contact between 16 June 2024 and 12 July 2024.

This resulted in over 1000 people clicking on the link or scanning the QR-code. There were 936 engagements using the official bit.ly link and an unknown amount using the original EU-survey link. There were 242 respondents of which 61 did not finish the complete questionnaire. This means that the final dataset contains 181 responses. On a 95% confidence level, this leads to a 7.3% margin of error.

The most responses came from Bulgaria and Romania, followed by Italy and Spain. There are fewer responses from smaller countries like Slovenia, Ireland, and Estonia, which could be explained by their population size. Unfortunately it turned out to be difficult to get responses from the large countries France and Germany. Although it is not a perfect distribution across the countries of the consortium partners, there is still input from all consortium countries. This in combination with the fact that the country of the organisation is not the most important characteristic for this study, makes that this does not hinder drawing conclusions from this analysis

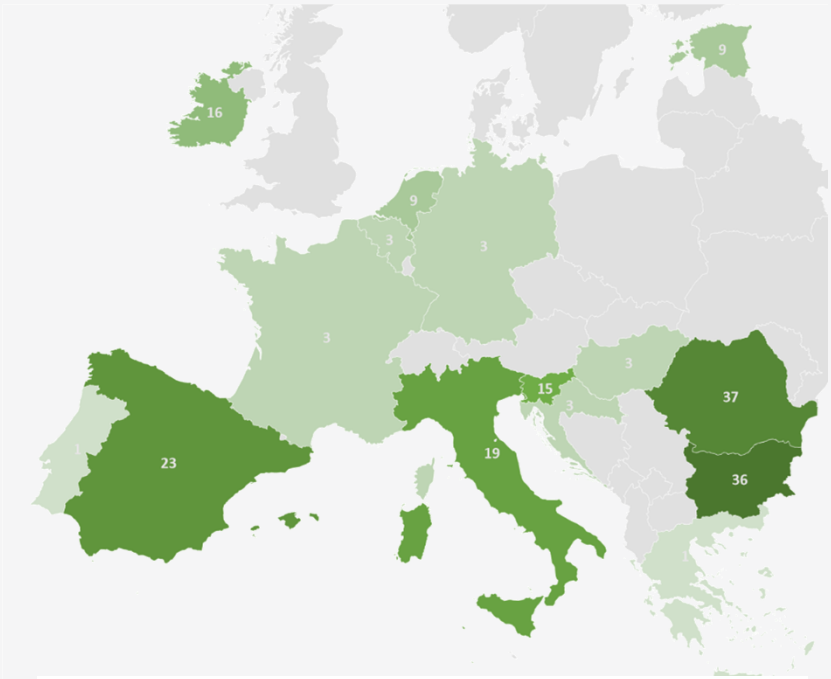


Figure 19 Respondents distribution across consortium countries

Another characteristic of the respondents is the size of the organisation they work in. In total 65% of the respondents are representing SMEs, being organisations with less than 250 employees. This almost evenly spread between micro (< 10 people), small (<50 people) and medium (<250

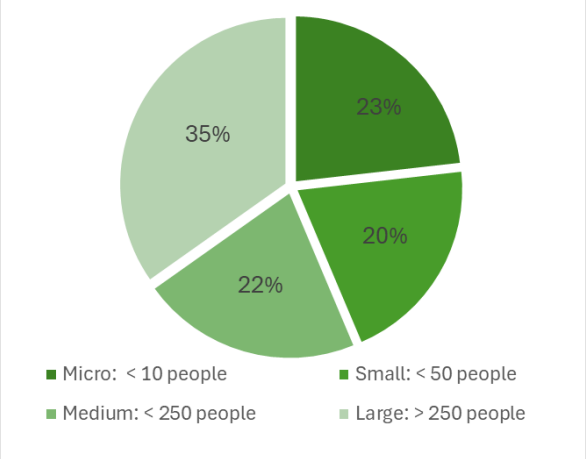


Figure 20 Number of employees in respondents organisation

people) size organisations. The fact that 35% of the organisations are large organisations means that they are overrepresented in this study, since only 0,2% of the organisations in the EU are large organisations[8]. A possible explanation could be that large organisations have more interest in this topic given for example that they have to comply with CSRD rules which (unlisted) SMEs don't[9]. In any case, this is something to take into account when analysing this data since it is very well possible that SMEs and large organisations have different needs for digital4sustainability roles, skills and education & training.

It is also relevant to have a brief look at the kinds of organisations that responded. Looking at relevant categories of organisations most responses were from general ICT organisations and private organisations in other sectors with still also 15% organisations that specifically focus on digital sustainability as a vendor, service provider or consultancy. With also almost 20% of the respondents from public organisations, it is a good mix of sorts of organisations with no direct concerns about influence this might have on findings.

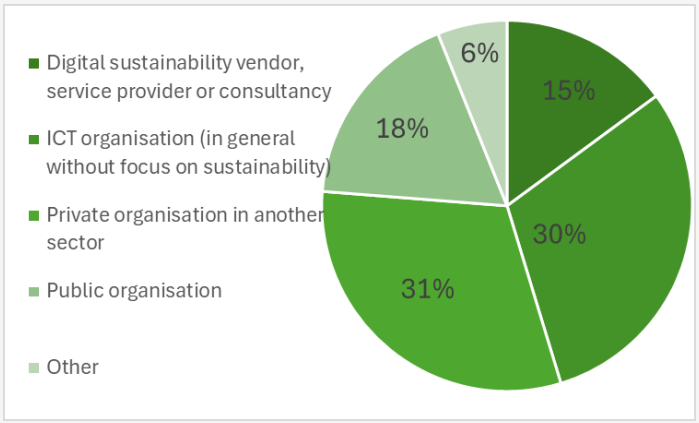


Figure 21 Kinds of organisation

The respondents also indicated the sector or sectors[10] their organisation is active in. The sector most mentioned is education, which indicates an over-representation of educational institutes.

[8] Eurostat. (2023, December 12). Large businesses generated half of EU's net turnover. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20231212-1

[9] European Commission. (n.d.). Corporate sustainability reporting. Retrieved October 11, 2024, from https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en?prefLang=en

[10] Eurostat. (2008). NACE Rev. 2. Statistical Classification of Economic Activities in the European Union. Office for Official Publications of the European Communities, Luxembourg. https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF

This also seems to be the case for the ICT-sector, but that is logical given the fact this study is about the digital field. Other sectors that are represented well are agriculture, energy, finance and insurance, manufacturing, and public administration. Besides the over-representation of the education sector, there are no other points of attention for the analysis.

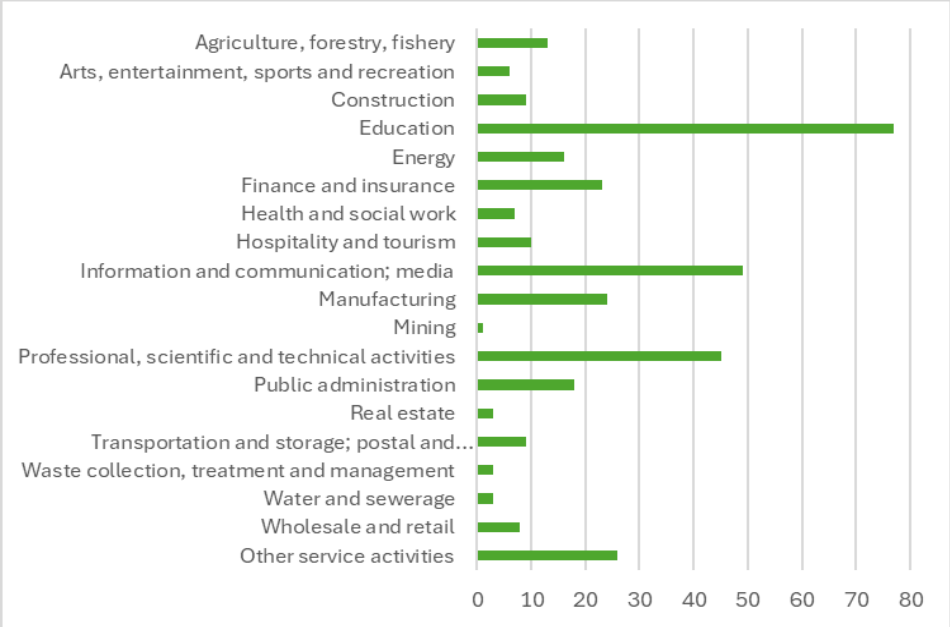


Figure 22 Sectors that organisations are active in

Looking at a last interesting aspect of the respondents, being the roles the respondents have within their organisations, there are a lot of owners and CEOs that respond themselves potentially indicating the importance of the topic. It is also good to see that people responsible for digital within their organisation like CIOs and ICT managers have responded. Finally it is clear that researcher are overrepresented in this study, which is consistent with the fact that the education sector is overrepresented.

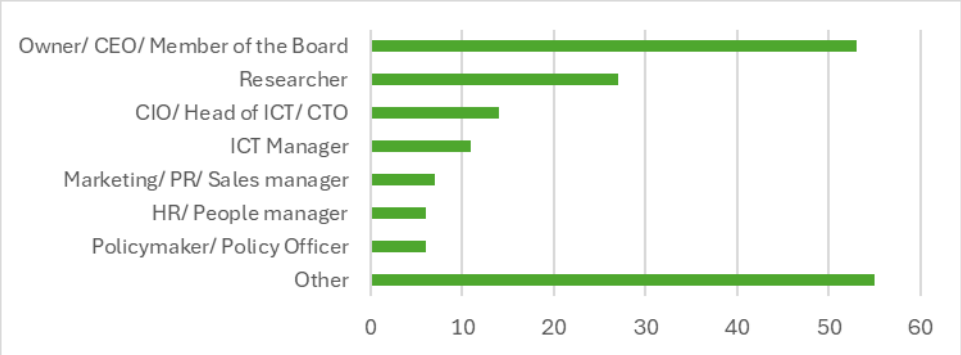


Figure 23 Roles of respondents in their organisation

4.3 Main findings

The findings of the questionnaire are organised according to the three main elements of the needs analysis: digital for sustainability roles, skills, and education & training.

4.3.1 Roles

Currently, the digital sustainability lead is the role of all roles studied that is already most present in organisations. This is followed by other organisation oriented roles digital sustainability consultant and sustainability business analyst. The more technical roles like sustainable technical specialist and software developer for sustainability are somewhat less present at the moment. Sustainability data roles, being specific sustainability data analysts, engineers, and scientists, are the least present at organisations at the moment.

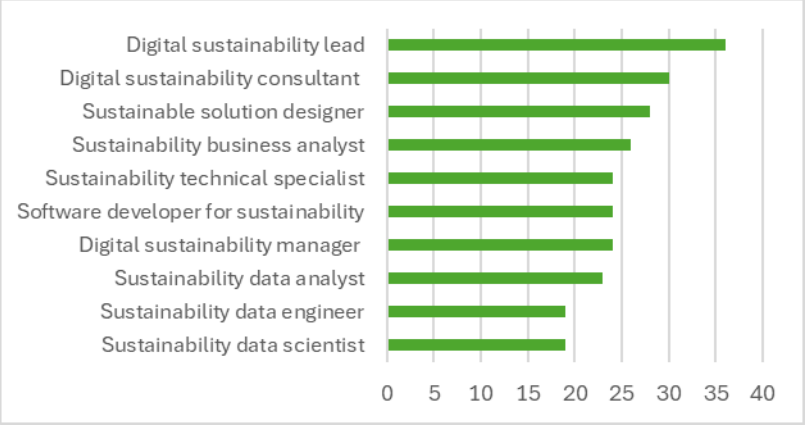


Figure 24 Roles already present in organisations

This picture only changes slightly looking at the current need and the need in the near future. The sustainability business analyst, digital sustainability lead and consultant are needed by the most organisations now and in the next three years. What is different is that quite a few organisations are searching now for sustainability data engineers, analysts, and scientists. This indicates there could also be an urgent need for people that can fulfil these roles, since they are already present in only a few organisations in comparison, but organisations are looking for these kind of specialists. There is a less urgent need for specific technical specialists and software developers, although it is expected that the demand for software developers for sustainability will pick up in the coming years.

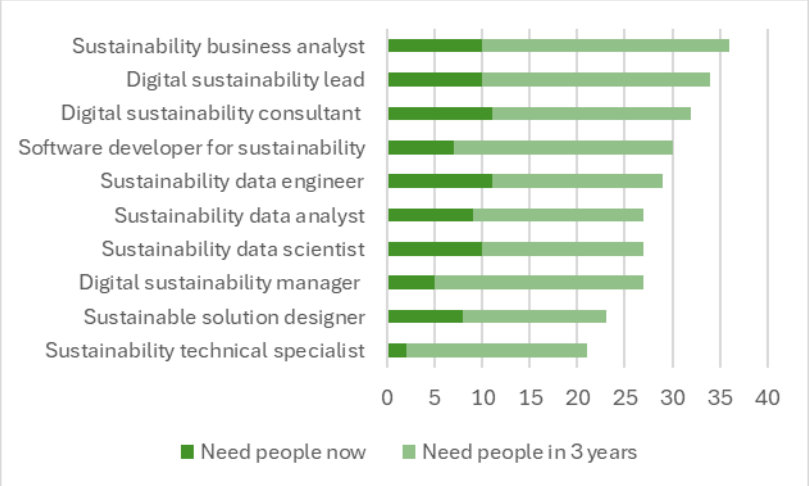


Figure 25 Needs for people in roles now and in three years

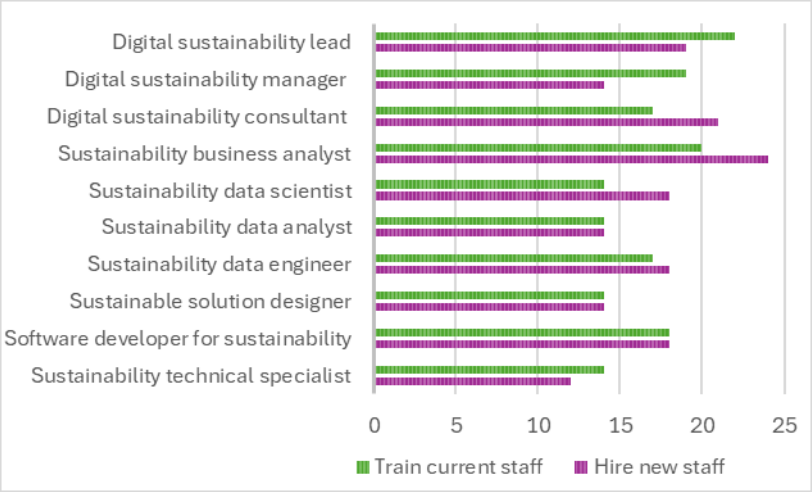


Figure 26 Train or hire new staff

Looking at how organisations are planning to cover the need for these roles, it shows that it is both popular to train current staff and to hire new staff. On the one hand internal upskilling is in comparison considered more important for roles like digital sustainability lead and manager, while on the other hand roles like sustainability business analyst and data scientist are more likely to be hired externally. It seems logical that this is also the case for consultants.

4.3.2 Skills

The next step is to identify what are the most important sustainability related skills and knowledge that are needed in these digital sustainability roles. This can be divided into specific sustainability topics and more transversal skills needed in the area of digital for sustainability. The first set of specific sustainability skills and knowledge shows that when talking about more overall, general topics, laws, regulations, and standards, are considered to be relevant for the largest amount of organisations. Other related topics like Sustainable Development Goals, CSR policy and reporting, and ESG reporting are also considered relevant, but none of these topics are often mentioned as being highly relevant. This suggests these topics are relevant as basics, but are not specifically at the core of what is needed.

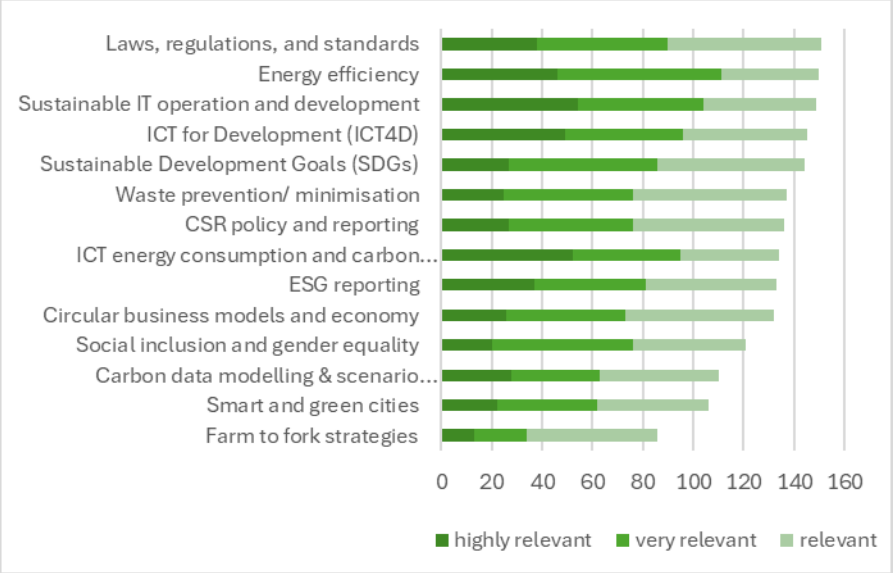


Figure 27 Relevant sustainability related skills and knowledge

Looking at sustainability areas energy efficiency and ICT for development score the highest. Areas like social inclusion and gender equality are rated somewhat less relevant, but specific areas like smart cities and farm to fork strategies are considered to be even less relevant. This can be explained by the fact that not every organisation is involved in these kind of areas and therefore not many organisations consider them to be relevant.

The ICT-industry related topics sustainable IT operations & development, and ICT energy consumption, & carbon footprint are considered highly relevant by many respondents.

The transversal skills and attitudes show that especially the very general skills that don't have a direct relationship to sustainability are considered the most relevant. These are skills like critical thinking, team work, willingness to learn, exploratory thinking, and strategic thinking. Looking at the sustainability related transversal skills and attitudes, valuing sustainability is considered to be the most important. Acting on that and show sustainable behaviour, is considered less important, while having a vision on sustainable futures is considered as relevant as acting sustainable. The aspect that is considered way less important is having political engagement to support sustainable action. Although well over 90% of the respondents think that the more general skills are relevant, still over 80% of the respondents think that specific sustainability related skills and attitudes are needed for people that are working in digital for sustainability.

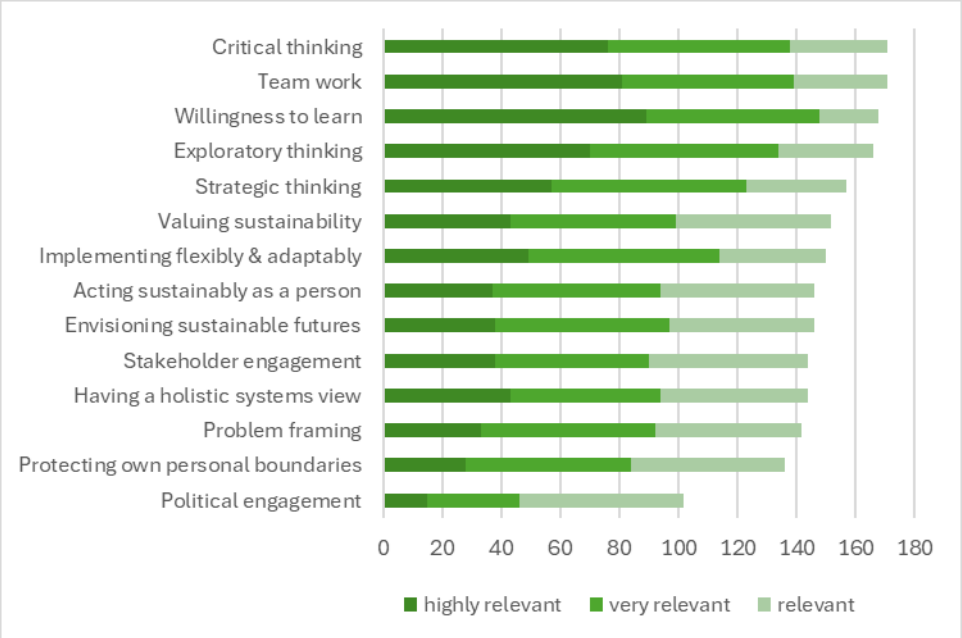


Figure 28 Transversal skills needed in the area of digital for sustainability

4.3.3 Education and training

The final main topic of the questionnaire is the views of the respondents on education and training of skills to professionals working or aspiring to work in the field of digital for sustainability. The first topic is about why people in organisations need to be upskilled. The most popular reaction is that simply new technology asks for new skills. Besides other reasons it is also important to notice that over 40 respondents indicate that people don't have the right skills when starting a job. This indicates that in a lot of cases it is not possible to find people that are already skilled sufficiently, which suggests a shortage of skilled professionals in the field. This could mean that people are not equipped with the right skills after formal education in some cases.

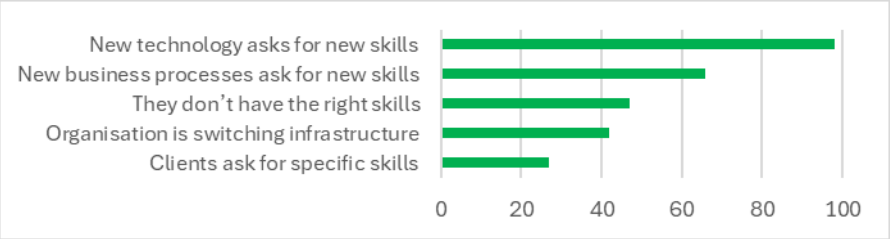
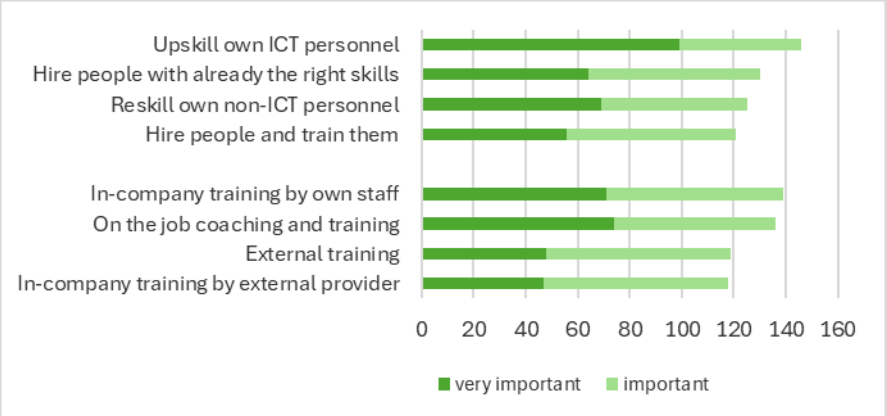


Figure 29 Reasons for having to train people

Almost of a quarter of the respondents state that their organisation has a backlog in training. Mainly this is because of a lack of time. Equally organisations don't have time to organise training and most importantly people have no time to do it. A smaller group even reports resistance towards training. Other issues are that organisations have no people to train others, and also that there is no (external) training available for the required skills, while a smaller number of respondents indicate that training is too expensive. These last points suggest there should be training available in an accessible way for the important sustainability related skills. The first points adds to the fact that training should be flexible, short, modular learning, so that it can fit into the schedules of learners.

The next question is who you are going to train the right skills to be able to fulfil the digital for sustainability roles? Most respondents indicate that upskilling own ICT personnel is the most important target group for training. Also, reskilling own non-ICT personnel is an option less preferred than ICT



personnel, but still considered an important option. It is somewhat remarkable that there is hardly any difference between hiring new people with the right skills and hiring people that need to be trained.

Concerning who is important for providing the training, it is clear that organisations prefer internal training by their own staff. This can be done either by internal training or by on the job coaching and learning. External training or in-company training by external providers is considered to be less important. This raises questions for example on how internal staff gets skilled on these new topics in the first place. The most logical explanation is that first a certain group of an organisation is trained and that they in return train the rest of the organisation. This would require a train-the-trainer model.

4.4 Analysis

The in-depth analysis is again structured using the main topics roles, skills, and education & training. The starting point is first to analyse the results for each of the questions. There are also checks whether some of the characteristics of the respondents (e.g. organisation size, sector) influences the results when this could be relevant.

4.4.1 Roles

The first question was whether organisations needed people in digital for sustainability roles in the first place. 76% of the respondents indicated that they need at least one category of these roles. The other 24% indicated that they don't have people in this role and also don't expect to need people in these roles. Although there is a slight overrepresentation of micro organisations that indicated this, amongst all sizes of organisations there are organisations that indicate that they don't need these roles with also 24% of the large organisations to indicate so. Looking at the organisations that do need the roles and checking the defined categories, there is demand for all three categories in almost equal amounts. This indicates that that all three categories need to be addressed.

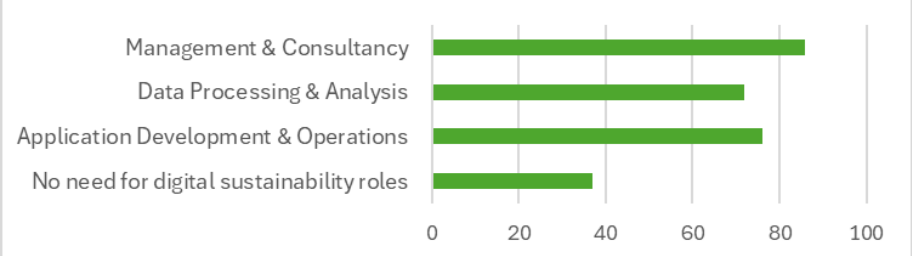


Figure 31 Categories of digital for sustainability roles needed

4.4.1.1 Management & Consultancy roles

The 86 respondents that indicated that they have and/or need people in these kind of digital for sustainability roles, also provided some more details about their needs for each of the three roles digital sustainability lead, manager, and consultant. For all three roles, more or less half of the organisations already has somebody working in the role and the other half does not. There are already some more digital sustainability leads within organisations than managers, but more important is how many people organisations need in these roles now and in the near future.

Figure 32 Organisations that have people working in management & consultancy roles

Figure 33 The need for management & consultancy roles

There are a few organisations that are looking for these roles now. They are looking both for leads and consultants with almost no organisations looking for digital sustainability managers. There are more organisations that indicate they predict needing these kind of roles within the next three years. This is equally for each of the three roles. Some of the organisations that have people working in these roles also indicate that they don't need extra people in these roles. It is logical that there is little need for extra leads, since in general an organisation will only need one digital sustainability lead.

Figure 34 How organisations are filling the management & consultancy roles

Looking on how they want to find people for those roles most organisations indicate they will both train current staff and hire new staff.

There is a difference between leads and managers on the one hand, and consultants on the other. Organisations expect to hire more new consultants and train less current staff in that role in comparison to the other roles. This suggests that upskilling of own personnel is more important for leads and managers, while consultants will more likely be people that are skilled or reskilled before joining an organisation.

4.4.1.2 Data processing & analysis roles

The four studied roles related to data processing & analysis are sustainability business analyst, data scientist, data analyst, and data engineer. The organisations indicating they have these roles, most of them have a sustainability business analyst. They are especially less likely to already have sustainability data scientists, but also less likely to have sustainability data analysts and engineers.

Given this difference it is interesting to see what the need for these roles is. There is an equal amount of organisations that indicate they need somebody in a certain role, so there is no difference between the roles, but looking to the needs in the coming 3 years, it shows that more organisations expect to need more sustainability business analysts. The other roles are needed in equal amount by organisations. The role of business analysis is therefore not only the most present role, but also the role most needed in the coming years, which indicates that this more business oriented role is more needed than the more technical. But considering that most technical skills are the same for scientists, data analysts, and data engineers, it also means that the skillsets for these roles overlap a lot, and that a person can quickly be upskilled between these roles. The focus therefore perhaps would be not of these specific roles, but on the shared skillset which are the foundation for all three roles.

Figure 35 Organisations that have people working in data processing & analysis roles

Figure 36 The need for data processing & analysis roles

Most organisations think that sustainability business analysts will be partly upskilled current staff, but mainly newly hired people. This is also the case for the other roles, but in those roles it seems to be more equally balanced between upskilling current staff and hiring new staff.

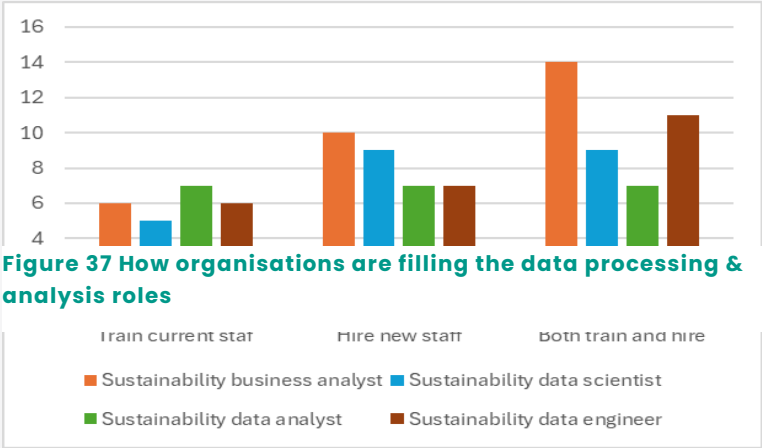


Figure 37 How organisations are filling the data processing & analysis roles

4.4.1.3 Application development & operations

The last group of roles on application development & operations consists of the roles sustainable solution designer, software developer for sustainability, and sustainability technical specialist. There are a few more organisations reporting they have a sustainable solution designer working in the organisation than the other two roles, but the difference is not much.

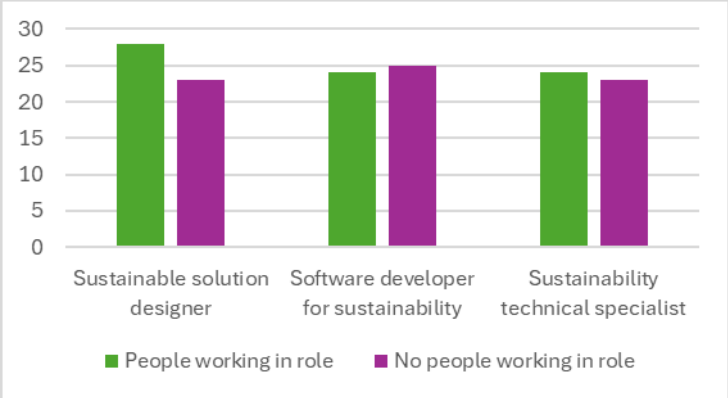


Figure 39 Organisations that have people working in application development & operations roles

Looking at the current need for extra people in these roles, it is clear that there is no need at the moment for sustainability technical specialists, and only some need for the other roles. Also, when checking the reported need in 3 years, it becomes clear that there is need reported by more organisations, but the need for software developers specialising in sustainable solutions is (somewhat higher).

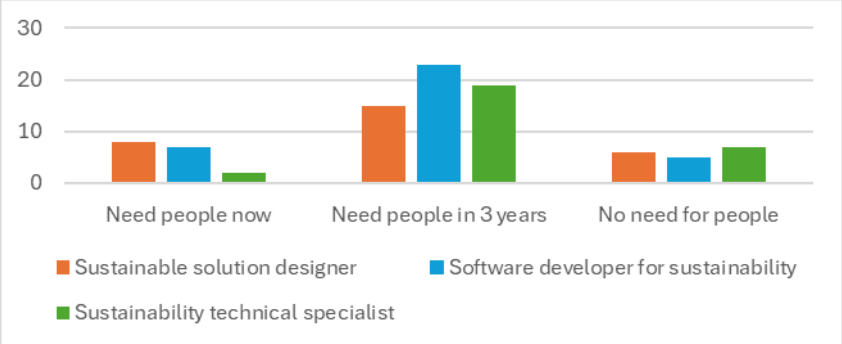


Figure 38 The need for application development & operations roles

The future need for solution designer is dropping even below technical specialists. It appears that software developers for sustainability are somewhat more needed than the other roles.

Finally, also the overview of the way that the needed staff is obtained, shows no striking results. There are somewhat higher numbers to hire or both train and hire extra developers than the other two roles, but this does not reveal any new insights.

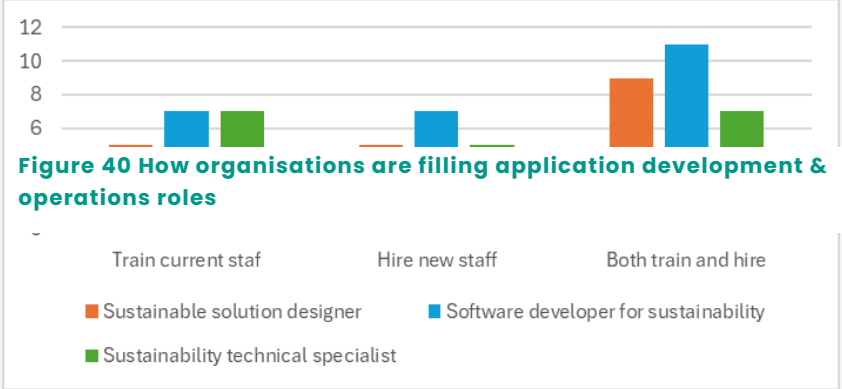


Figure 40 How organisations are filling application development & operations roles

4.4.2 Skills

The focus of the skills questions was on what specific additional or other skills does a professional in a digital for sustainability role needs other than a digital/ ICT professional in general. This was categorised in sustainability related skills and knowledge, general sustainability competences, and transversal/ soft skills.

4.4.2.1 Sustainability related skills and knowledge

The question about the sustainability related skills and knowledge resulted some differences in importance between the skills. Looking at the more general sustainability related knowledge and skills, each topic is considered to be highly or very relevant by between 40 to 50 percent of the respondents. If a distinction must be made, then circular business models and economy are considered to be slightly less relevant than the laws, regulations, and standards related topics which also includes the basic regulations that are the foundation of Corporate Social Responsibility (CSR) policy and reporting and Environmental, Social, and Governance (ESG) reporting. Although the Sustainable Development Goals (SDGs) are considered less highly relevant, they are considered relevant to a certain extend by over 90% of the respondents, in line with the other topics.

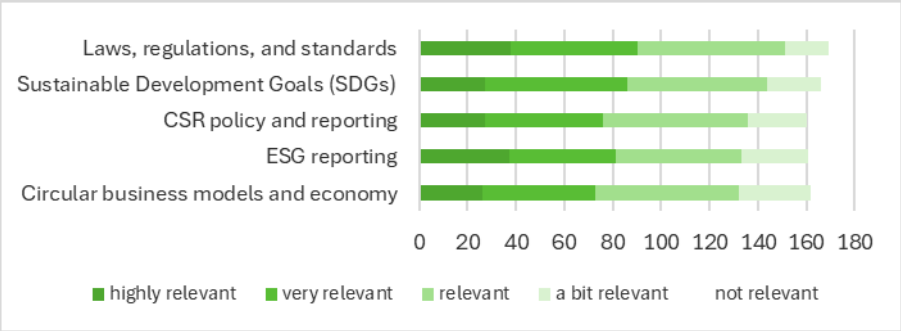


Figure 41 General sustainability related skills & knowledge

Respondents was also asked how relevant they thought skills and knowledge on certain topics of sustainability actions are. The topic of ICT for Development (ICT4D) was considered het most in any way relevant, but only looking at highly or very relevance of topics it is surpassed by energy efficiency (61% versus 53%). Both skills and knowledge on social inclusion & gender equality and waste

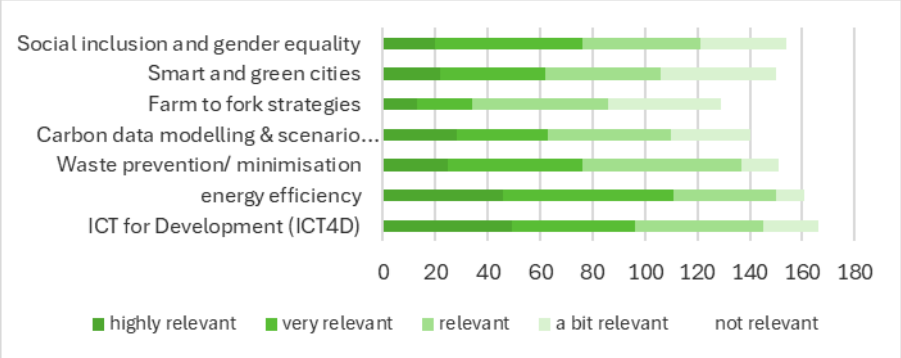


Figure 42 Skills and knowledge on sustainability topics

prevention/ minimisation are considered to be equally important with 42% of the respondents stating it is highly or very relevant. It becomes clear that smart & green cities (34%) and carbon data modelling & scenario planning (35%) are already considered more niche and highly or very relevant for less organisations. This really is the fact for farm to fork strategies which is only highly or very relevant for 19% of the respondents.

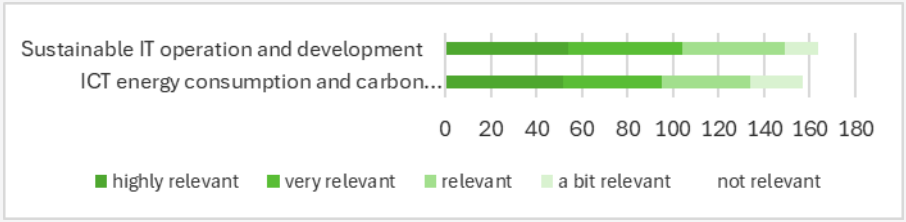


Figure 43 Topics on sustainable ICT

The last two topics are related to the sustainability of the ICT sector itself. Both sustainable IT operation & development (57%) and ICT energy consumption & carbon footprint (52%) are considered highly or very relevant by the majority of the respondents. It indicates that it is valued that the digital solutions for sustainability are also sustainable as possible themselves.

4.4.2.2 Transversal sustainability related skills

The transversal sustainability related skills and attitudes are related directly or indirectly to sustainability, but are important to every professional working the this field and not only specifically focused on a certain topic or area. All skills are considered to be of least a bit relevant by 90% or more of the respondents. The only exception to that is political engagement which only 77% find of any relevance, with only a quarter labelling it highly or very relevant. This is therefore the least important of all skills and attitudes mentioned. Two skills are labelled more highly or very relevant than others: strategic thinking (68%) and implementing flexibly (63%). Strategic thinking is about planning action towards sustainability and implementing flexibly deals with adapting to change and handling

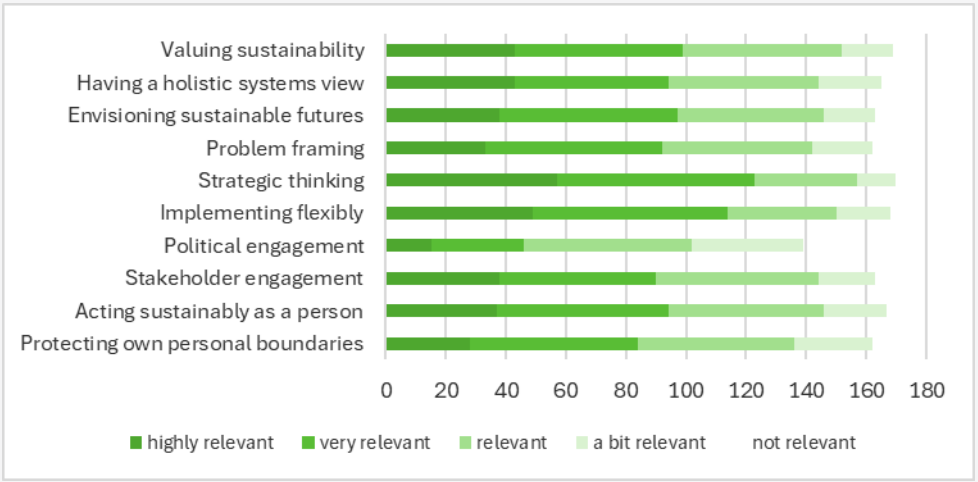


Figure 44 Transversal sustainability related skills and attitudes

ambiguity. All other skills and attitudes are highly or very relevant according to half of the respondents and could therefore be looked at as equally important.

4.4.2.3 Transversal soft skills

The final set of skills are general transversal skills that are relevant having in any professional environment. Besides the beforehand selected four most important ones to professionals in general, respondents could also add other transversal skills they thought are relevant for people working in digital for sustainability roles. It was confirmed that these four transversal skills are indeed also important in the field of digital for sustainability given the fact that they all are relevant to over 95% of the respondents, and highly or very relevant to 74 (exploratory thinking) to 82 (willingness to learn) percent of the respondents.

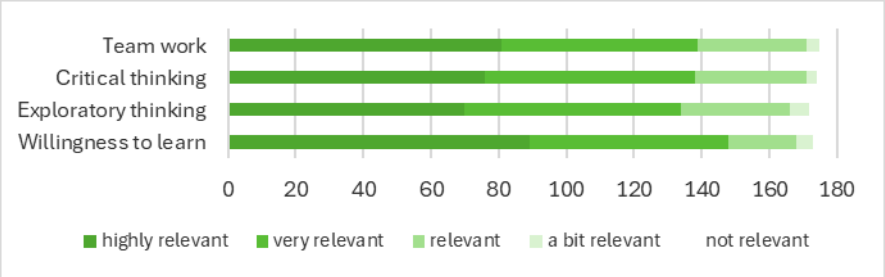


Figure 45 Most important transversal soft skills

Just over twenty percent of the respondents added other transversal skills they thought are essential in this field. Communication skills in general were mentioned most, while most other suggestions can be deducted to being part of the earlier discussed transversal sustainability skills or to one of the four general transversal skills. These mentioned extra skills are skills like change management, dealing ambiguity, curiosity, and openness to new developments.

4.4.3 Education & training

The last part of the questionnaire deals with the need for education and training on the identified skills to prepare people for digital for sustainability roles.

4.4.3.1 Reasons for education & training

Seventy-one percent of the respondents indicated that their organisation needs people to be educated or trained in the field of digital for sustainability. The main reason for this is that new technological developments ask for new skills according to the respondents. Other, way less, mentioned reasons are that new

Figure 46 Main reasons for having to train people in digital sustainability roles

business processes in general require new skills, and that the organisation is switching infrastructure, like for example switching to cloud. These two reasons related to changes in the organisation still make up a good portion of the causes for education & training needs. Another reason is that people don't have the right skills when starting the job, which is still mentioned by a third of the organisations with education & training needs. A reason that is apparently less important is clients (internal and/or external) asking for specific skills, since this is only mentioned by about a fifth of the respondents with these needs.

Twenty-two percent of the respondents also indicated that there is a backlog in education & training of personnel. The main reason according to them is that people simply don't have time for training. This suggests that training should be offered flexibly and should be modular so people can do divide the learning in small parts to fit their schedule. Besides people don't having time, there is also a smaller group that are resisting training. There are also some organisations that don't have time to organise the training, or don't have people to train others. That they don't have people to train others is especially problematic if there is no external training available for specific skills. Some organisations indicate that training is too expensive which argues in favour of openly available training materials.

Figure 47 Reasons for backlog in training

4.4.3.2 Preferred ways of learning

The last aspect covered in this questionnaire is how organisations prefer training their people to equip them with the needed skills. The first question is how an organisation obtains correctly skilled professionals. All the approaches, upskilling, reskilling, and hiring, are important to at least some extent to way over eighty percent of the respondents. The approach most find very important is the upskilling own ICT personnel (55%), so they are ready and able to design,

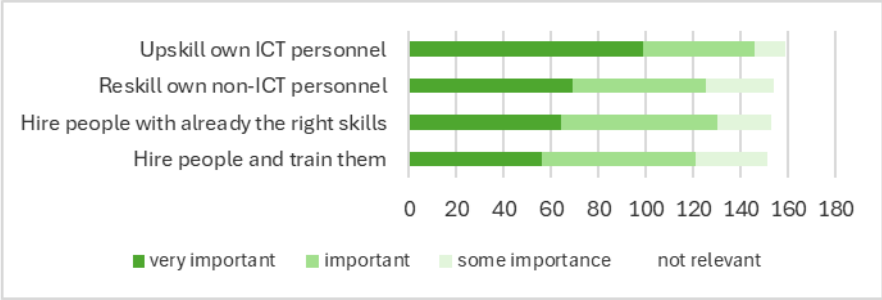


Figure 48 Approaches to obtain skilled professionals

develop and deploy digital solutions that contribute to sustainability. This suggests that in the first place training programmes are needed aimed at ICT professionals. The other options are considered to be equally very important (between 31 and 38%). Reskilling non-ICT personnel is also still an important option for organisations, but a somewhat unexpected result is that organisations are equally interested in hiring people with already the right skills or hiring people that need to be trained. It indicates that organisations apparently don't think enough people with the right skills are available, so they are willing to train them themselves as well.

There is a difference though in the preference for educational background of people when hiring. This difference is between people who are educated already in a relevant field, mainly being ICT, but it could also be a background in sustainability, and people from any other field. Looking at formal professional education (VET) 36% of the respondents state that education in a relevant field is very important, against 24% in any field. At the bachelor and master level it differs almost the same, with 32% finding a relevant education very important, against 19% in any field. Relevant certifications for the digital for sustainability role, are considered to be equally important as a formal professional or bachelor/master degree in a relevant field. This indicates that certifications are an important tool to prove that professionals are reskilled to the field of digital for sustainability.

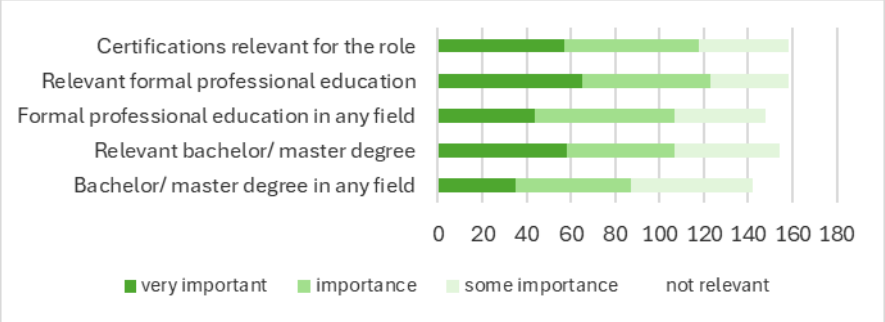


Figure 49 Importance of educational background when hiring

Finally, a look at the training strategies to train existing and new staff that do not have the right skills yet. All strategies are considered important to some extent by almost 90% of the respondents, but there is a big difference when it comes what they label as a very important strategy. That shows that internal training by own people is preferred by far. This is the

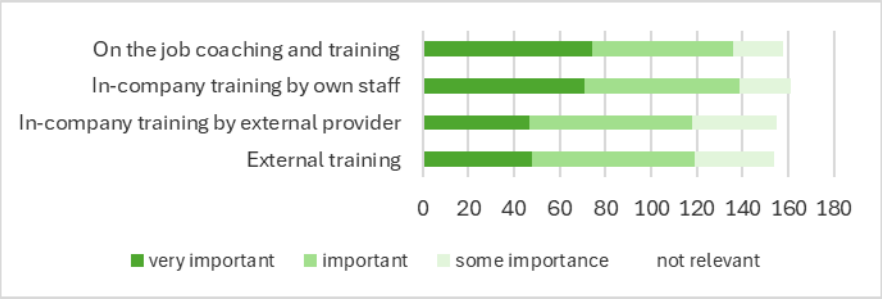


Figure 50 Importance of training strategies

case both for on the job coaching and training (41%) and in-company training by own staff (39%). This in contrast to external trainers for both in-company training (26%) as external training (27%). This suggests it is very important to make sure there are sufficient skilled people in organisations to train others. This means they not only need to have the right skills themselves, they should also be able to train these to others, which could mean the train-the-trainer programmes would be an important focal point.

4.5 The EU Survey Digital4Sustainability 2024 questionnaire

Digital4Sustainability 2024 questionnaire

Fields marked with * are mandatory.

WELCOME TO THE EU DIGITAL4SUSTAINABILITY - SKILLS AND ROLES SURVEY

This questionnaire is a key element of the **Digital4Sustainability project,** a 4-years transnational initiative funded by the European Union. The project involves 24 full partners and 5 associated partners spanning 13 European Member States. All partners are joining forces to fast-track a digital and sustainable transition (twin transition) throughout European industry.

The project aims to leverage Europe's **digital sustainability**, and focuses on how digitalisation can support sustainability with the design, development and deployment of **digital technologies and innovations that seek to proactively enable, accelerate and scale environmentally and socially sustainable development.** The project consortium will promote the development of professional skills and roles in digital sustainability and support the development of a skilled digital sustainability workforce. More information about the project can be found on this page.

In this survey, we are interested in the intersection between digital and sustainability and want to learn more about **digitalisation for sustainability**: What roles and what skills are needed?

Your participation in this survey is essential as it will help us to map this emerging area and better understand the professional skills and workforce needs related to digital sustainability. The

information gathered by this survey will feed the definition of a **new Digital Sustainability Skills Strategy and learning programmes for training digital sustainability professionals.**

The survey is composed of the following four sections:

A. General questions about your organisation
B. Questions on roles
C. Questions on skills
D. Questions on education and training

The survey will take only fifteen minutes at most to complete. In return, you'll receive our study results, the very first report on the current landscape of digital sustainability skills needs in Europe! At the end of the questionnaire you can indicate whether you are interested and fill in your contact details. You can also become part of our community and get involved in future stages of the Digital4Sustainability project and stay up to date with Digital4Sustainability news, events and project progress.

We thank you in advance for your valuable contribution!

Co-funded by the European Union

A. About your organisation

The questionnaire is aimed at organisations with their own need for professionals with digital sustainability skills. **Digital sustainability skills** are all those skills related to the **designing, developing, deploying and regulating of digital technologies that accelerate environmentally and socially sustainable development.**

Organisations that need these skills are organisations with in-house staff responsible for digital products / services aimed at an environmentally and socially sustainable development. These are mainly organisations in the ICT sector and organisations with their own ICT department.

Please also read the extra information by clicking on the question marks.

*A.1. In which EU country is your organisation located?

Please enter the country the organisation is registered in. It is only possible to participate if (a part of) the organisation is located in the EU. Multinationals should name the country in which most people that use skills in the area of digital sustainability work. If this is not in the EU, please state the EU country of the responding part of the organisation.

- Austria
- Belgium
- Bulgaria
- Croatia
- Cyprus
- Czechia
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Ireland
- Italy
- Latvia
- Lithuania
- Luxembourg
- Malta
- Netherlands
- Poland
- Portugal
- Romania
- Slovak Republic
- Slovenia
- Spain
- Sweden
- *Other*

*A.2. What is the size of the organisation? (in persons employed in the organisation in the EU) The size of the organisation based on the total amount of people working in the organisation in the specific country, so not the total size of the organisation if it is an international organisation. Micro: less than

- 10 people working in the organisation
- Small: less than 50 people
- Medium: less than 250
- people Large: over 250

people

*A.3. To what category does your organisation belong?

Organisations should have a demand for in-house professional digital sustainability skills and/or roles. These can be either organisations in the ICT/ digital sector, or organisations in other sectors with these skills need in for example their IT department.

Organisations that outsource these skills needs are not part of the sample of this questionnaire.

- Digital sustainability vendor, service provider or consultancy (providing digital solutions for sustainability)
- ICT organisation (in general without specific focus on sustainability)
- Private organisation in another sector
- Public organisation
- Other

A.3.1. What is the main digital service/ ICT activity of your organisation?

A.3.2. To what category does your organisation belong?

*A.4. In which sector is your organisation active?

Multiple options are possible

Based on NACE Rev. 2 (Eurostat - Statistical classification of economic activities in the European Community).

- ☐ Agriculture, forestry, fishery
- ☐ Arts, entertainment, sports and recreation
- ☐ Construction
- ☐ Education
- ☐ Energy
- ☐ Finance and insurance
- ☐ Health and social work
- ☐ Hospitality and tourism
- ☐ Information and communication; media
- ☐ Manufacturing
- ☐ Mining
- ☐ Professional, scientific and technical activities
- ☐ Public administration
- ☐ Real estate
- ☐ Transportation and storage; postal and courier services
- ☐ Waste collection, treatment and management
- ☐ Water and sewerage
- ☐ Wholesale and retail
- ☐ Other service activities

A.4.1. Please indicate the agriculture, forestry, fishery subsector:

- ☐ Agriculture
- ☐
- ☐ Forestry
- Fishery

A.4.2. Please indicate the energy subsector:

- ☐ Electricity
- ☐ Gas
- ☐ Steam and air conditioning supply
- ☐ Hydrogen

A.4.3. Please indicate the health and social work subsector:

- ☐ Human health activities
- ☐ Residential care activities
- ☐ Social work activities without
- ☐ accommodation Other

A.4.4. Please indicate the hospitality and tourism subsector:

- ☐ Accomodation and food services
- ☐ Travel agency and tour operator
- ☐ activities Other

A.4.5. Please indicate the information, communication and media subsector:

- ☐ Data processing
- ☐ Telecommunications
- ☐ Computer programming
- ☐ Computer consultancy
- ☐ Web portals, platforms
- ☐ Software publishing
- ☐ Publishing - other (books, journals etc.)
- ☐ Media (video, television, broadcasting
- ☐ etc.) Other information services

A.4.6. Please indicate the manufacturing subsector:

- ☐ Manufacturing of **consumer goods** except food, beverages, tobacco, textile, apparel, leather
- ☐ Manufacturing of **computers, electronics and optical products,** except medical devices
- ☐ Manufacturing of **medical devices**
- ☐ Manufacturing of **fabricated metal products**, except machinery and equipment
- ☐ Manufacturing of **food, beverages and tobacco**
- ☐ Manufacturing of **tobacco**
- ☐ Manufacturing of **machinery and equipment**
- ☐ Manufacturing of **textile, apparel, leather, footwear** and related products
- ☐ Manufacturing of **transport equipment**

Manufacturing of **chemicals**

A.4.7. Please indicate the professional, scientific and technical subsector:

- ☐ Legal and accounting activities
- ☐ Head offices; Management consultancy
- ☐ Architectural and engineering activities
- ☐ Scientific research and development
- ☐ Advertising and market research
- ☐ Other professional, scientific and technical activities

A.4.8. Please indicate the transportation

- [ ] subsector: Air
- [ ] Land
- [ ] Water
- [ ] Warehousing
- [ ] Postal and courier services

A.4.9. Please indicate the services subsector:

- [ ] Rental and leasing activities
- [ ] Employment activities
- [ ] Security and investigation activities
- [ ] Services to buildings - facility management
- [ ] Office administrative and support
- [ ] activities Other services

A.5. What is your role within the organisation?

- ( ) Owner/ CEO/ Member of the Board
- ( ) CIO/ Head of ICT/ CTO
- ( ) ICT Manager
- ( ) HR/ People manager
- ( ) Marketing/ PR/ Sales manager
- ( ) Researcher
- ( ) Policymaker/ Policy Officer
- ( ) Other

B. Digital sustainability roles in the organisation

The questions in this part of the survey focus on the **roles in an organisation that require substantial digital sustainability skills**, meaning these skills are central to the job. These are people with at least partial responsibility for digital innovation that seeks to proactively enable, accelerate and scale environmentally and socially sustainable development: **digitalisation for sustainability**.

The questions focus on role profiles within 3 main areas: **(1) Management & Consultancy, (2) Data Processing & Analysis and (3) Application Development & Operations.**

Role profiles are formulated in such a way that they cover a wide range of roles that may have different names and differ slightly in tasks and specific characteristics in practice. Generally, these roles share the same key competences required to fulfill the role.

In this survey, **we are interested in the roles your organisation needs and not in jobs**. Please consider that a role differs from a job. For example, if one person in your organisation combines several roles related to digital sustainability, you can enter all these different roles. A person with a different function title can also have a digital sustainability role. For example, the person working in the function of software developer can also have the role of sustainable software developer. In this case, you can state that your organisation has people working in the role of a sustainable software developer.

It is also possible to add a role if this role requires substantial digital sustainability skills and cannot be categorised in one of the other roles.

Alternative names of the roles can be found by clicking on the question marks.

Select the areas in which people already work in digital sustainability roles / in which people are needed now / are likely to be needed in the future within your organisation:

- ☐ Management & Consultancy
- ☐ Data Processing & Analysis
- ☐ Application Development & Operations
- ☐ We don't have people working in digital sustainability roles and don't expect to need them in the future

Management & Consultancy

Three digital sustainability roles can be recognised in the area of management & consultancy: **Digital Sustainability Lead, Digital Sustainability Manager and Digital Sustainability Consultant.** The questions below relate to these roles within your organisation.
Alternative names of the roles can be found by clicking on the question marks. There is also the possibility to add roles in the last question of this section.
B.1. Which of the following statements are true about the **Digital Sustainability Lead** role within your organisation?
(Multiple answers are possible)

The Digital Sustainability Lead defines and implements a **digital sustainability strategy, policy, and governance** across the organisation.

Provides leadership for the implementation and development of sustainability by the organisation's architecture and applications.

Alternative names: ICT/ IT Sustainability Lead, Digital Sustainability General Manager, ICT/ IT Sustainability General Manager

- ☐ We have people working in this role
- ☐ We do not have people working in this role
- ☐ We need (extra) people in this role now
- ☐ We expect to need (extra) people in this role within three years
- ☐ We do not need (extra) people in
- ☐ this role I don't know

B1.1 How will your organisation solve the need for (extra) people in this role?

- ☐ We will train current staff
- ☐ We will hire new staff with the right skills

B.2. Which of the following statements are true about the **Digital Sustainability Manager** role within your organisation?

(Multiple answers are possible)

The Digital Sustainability Manager **proposes, plans and manages the functional development** of the information system, focusing upon sustainability. Ensures the continuous enhancement of sustainability by ICT.

Alternative name: ICT/IT Sustainability

- ☐ Manager We have people working in
- ☐ this role
- ☐ We do not have people working in this role
- ☐ We need (extra) people in this role now
- ☐ We expect to need (extra) people in this role within three years
- ☐ We do not need (extra) people in

this role I don't know

B.2.1. How will your organisation solve the need for (extra) people in this role?

- ☐ We will train current staff
- ☐ We will hire new staff with the right skills

B.3. Which of the following statements are true about the **Digital Sustainability Consultant** role within your organisation?

(Multiple answers are possible)

The Digital Sustainability Consultant **advises organisations on their digital sustainability strategy and its implementation** of applying digital technologies to reach sustainability goals and add value to a business in the most effective and efficient manner.

Alternative names: Digital Sustainability Advisor, ICT/ IT Sustainability Advisor, ICT/ IT Sustainability Consultant, ICT/IT Sustainability Systems Consultant We have people working in this role

- [ ] We do not have people working in this role
- [ ] We need (extra) people in this role now
- [ ] We expect to need (extra) people in this role within three years
- [ ] We do not need (extra) people in this role
- [ ] I don't know

B.3.1. How will your organisation solve the need for (extra) people in this role?

- [ ] We will train current staff
- [ ] We will hire new staff with the right skills

B.4. Do you have or need **another role** that requires digital sustainability skills in the area of management & consultancy within your organisation, but cannot be categorised in one of the three roles above?

- ( ) Yes
- ( ) No

B.4.1. Name of the role

B.4.2. Short description of the role

B.4.3. Which of the following statements are true about this role in the organisation?

- [ ] We have people working in this role
- [ ] We do not have people working in this role
- [ ] We need (extra) people in this role now
- [ ] We expect to need (extra) people in this role within three years
- [ ] We do not need (extra) people in
- [ ] this role I don't know

B.4.3.1. How will your organisation solve the need for (extra) people in this role?

- [ ] We will train current staff
- [ ] We will hire new staff with the right skills

B.5. Do you have or need **another role** that requires digital sustainability skills in the area of management/ consultancy within your organisation, but cannot be categorised in one of the three roles above?

- ○ Yes
- ○ No

B.5.1. Name of the role

B.5.2. Short description of the role

B.5.3. Which of the following statements are true about this role in the organisation?

- ☐ We have people working in this role
- ☐ We do not have people working in this role
- ☐ We need (extra) people in this role now
- ☐ We expect to need (extra) people in this role within three years
- ☐ We do not need (extra) people in
- ☐ this role I don't know

B.5.3.1. How will your organisation solve the need for (extra) people in this role?

- ☐ We will train current staff
- ☐ We will hire new staff with the right skills

Data processing & Analysis

Four digital sustainability roles can be recognised in the area of data processing & analysis: **Sustainability Business Analyst, Sustainability Data Scientist, Sustainability Data Analyst and Sustainability Data Engineer**. The questions below relate to these roles within your organisation.
Alternative names of the roles can be found by clicking on the question marks. There is also the possibility to add roles in the last question of this section.

B.6. Which of the following statements are true about the **Sustainability Business Analyst** role within your organisation?
(Multiple answers are possible)

The Sustainability Business Analyst **analyses an organisation's processes and systems and optimises business performance with regard to sustainability** through technology application. Provides possible ICT solutions compliant with the digital sustainability strategy. Alternative names: ICT/ IT Business Analyst Sustainability, Business Analyst Sustainability We have people

- ☐ working in this role
- ☐ We do not have people working in this role
- ☐ We need (extra) people in this role now
- ☐ We expect to need (extra) people in this role within three years
- ☐ We do not need (extra) people in
- ☐ this role I don't know

B.6.1. How will your organisation solve the need for (extra) people in this role?

- ☐ We will train current staff
- ☐ We will hire new staff with the right skills

B.7. Which of the following statements are true about the **Sustainability Data Scientist** role within your organisation?
(Multiple answers are possible)

The Sustainability Data Scientist **delivers insights from data by optimising the analytics process focusing on sustainability**. Creates, identifies, selects and optimises the mathematical models, the algorithms and predictive models to deliver insights in sustainability aspects, applying advanced programming techniques.

- ☐ We have people working in this role
- ☐ We do not have people working in this role
- ☐ We need (extra) people in this role now
- ☐ We expect to need (extra) people in this role within three years
- ☐ We do not need (extra) people in
- ☐ this role I don't know

B.7.1 How will your organisation solve the need for (extra) people in this role?

- ☐ We will train current staff
- ☐ We will hire new staff with the right skills

B.8. Which of the following statements are true about the **Sustainability Data Analyst** role within your organisation?
(Multiple answers are possible)

The Sustainability Data Analyst **imports, inspects, cleans, transforms, validates, models and analyses collections of data with regard to sustainability**. Ensures that the data sources and repositories provide consistent and reliable data. Prepares sustainability dashboards and management reports.

- [ ] We have people working in this role
- [ ] We do not have people working in this role
- [ ] We need (extra) people in this role now
- [ ] We expect to need (extra) people in this role within three years
- [ ] We do not need (extra) people in
- [ ] this role I don't know

B.8.1. How will your organisation solve the need for (extra) people in this role?

- [ ] We will train current staff
- [ ] We will hire new staff with the right skills

B.9. Which of the following statements are true about the **Sustainability Data Engineer** role within your organisation?
(Multiple answers are possible)

The Sustainability Data Engineer **builds and maintains systems** that collect, manage, and convert raw data into usable information regarding sustainability **for data scientists and analysts to interpret**.

- [ ] We have people working in this role
- [ ] We do not have people working in this role
- [ ] We need (extra) people in this role now
- [ ] We expect to need (extra) people in this role within three years
- [ ] We do not need (extra) people in
- [ ] this role I don't know

B.9.1. How will your organisation solve the need for (extra) people in this role?

- [ ] We will train current staff
- [ ] We will hire new staff with the right skills

B.10. Do you have or need **another role** that requires digital sustainability skills in the area of data processing and analysis within your organisation, but cannot be categorised in one of the four roles above?

- ( ) Yes
- ( ) No

B.10.1. Name of the role

B.10.2. Short description of the role

B.10.3. Which of the following statements are true about this role in the organisation?

- [ ] We have people working in this role
- [ ] We do not have people working in this role
- [ ] We need (extra) people in this role now
- [ ] We expect to need (extra) people in this role within three years
- [ ] We do not need (extra) people in
- [ ] this role I don't know

B.10.3.1. How will your organisation solve the need for (extra) people in this role?

- [ ] We will train current staff
- [ ] We will hire new staff with the right skills

B.11. Do you have or need **another role** that requires digital sustainability skills in the area of data processing and analysis within your organisation, but cannot be categorised in one of the four roles above?

- ( ) Yes
- ( ) No

B.11.1. Name of the role

B.11.2. Short description of the role

B.11.3. Which of the following statements are true about this role in the organisation?

- [ ] We have people working in this role
- [ ] We do not have people working in this role
- [ ] We need (extra) people in this role now

- ☐ We expect to need (extra) people in this role within three years
- ☐ We do not need (extra) people in
- ☐ this role I don't know

B.11.3.1. How will your organisation solve the need for (extra) people in this role?

- ☐ We will train current staff
- ☐ We will hire new staff with the right skills

Application Development & Operations

Three digital sustainability roles can be recognised in the area of application development & operations: **Su stainability Solution Designer, Software Developer for Sustainability and Sustainability Technical Specialist.** The questions below relate to these roles within your organisation. Alternative names of the roles can be found by clicking on the question marks. There is also the possibility to add roles in the last question of this section.

B.12. Which of the following statements are true about the **Sustainability Solution Designer** role within your organisation?
(Multiple answers are possible)

The Sustainability Solution Designer **proposes and designs solutions that support sustainability** in line with technical architecture which fit business requirements and support change.

- ☐ We have people working in this role
- ☐ We do not have people working in this role
- ☐ We need (extra) people in this role now
- ☐ We expect to need (extra) people in this role within three years
- ☐ We do not need (extra) people in
- ☐ this role I don't know

B.12.1 How will your organisation solve the need for (extra) people in this role?

- ☐ We will train current staff
- ☐ We will hire new staff with the right skills

B.13. Which of the following statements are true about the **Software Developer for Sustainability** role within your organisation? (Multiple answers are possible)

The Software Developer for Sustainability designs and/ or codes components to meet sustainability specifications. **Builds and implements ICT applications and components that support sustainability.**

Alternative name: Software Engineer in

- [ ] Sustainability We have people working in
- [ ] this role
- [ ] We do not have people working in this role
- [ ] We need (extra) people in this role now
- [ ] We expect to need (extra) people in this role within three years
- [ ] We do not need (extra) people in

this role I don't know

B.13.1 How will your organisation solve the need for (extra) people in this role?

- We will train current staff
- We will hire new staff with the right skills

B.14. Which of the following statements are true about the **Sustainability Technical Specialist** role within your organisation?
(Multiple answers are possible)

The Sustainability Technical Specialist **installs, maintains and repairs** hardware, software and service applications that support sustainability.

Alternative name: Digital Sustainability

- [ ] Technician We have people working in
- [ ] this role
- [ ] We do not have people working in this role
- [ ] We need (extra) people in this role now
- [ ] We expect to need (extra) people in this role within three years
- [ ] We do not need (extra) people in

this role I don't know

B.14.1 How will your organisation solve the need for (extra) people in this role?

- [ ] We will train current staff
- [ ] We will hire new staff with the right skills

B.15. Do you have or need **another role** that requires digital sustainability skills in the area of application development and operations within your organisation, but cannot be categorised in one of the three roles above? Yes

- ( ) No
- ( )

B.15.1. Name of the role

B.15.2. Short description of the role

B.15.3. Which of the following statements are true about this role in the organisation?We have people

- ☐ working in this role
- ☐ We do not have people working in this role
- ☐ We need (extra) people in this role now
- ☐ We expect to need (extra) people in this role within three years
- ☐ We do not need (extra) people in
- ☐ this role I don't know

B.15.3.1 How will your organisation solve the need for (extra) people in this role?

- ☐ We will train current staff
- ☐ We will hire new staff with the right skills

B.16. Do you have or need **another role** that requires digital sustainability skills in the area of application development and operations within your organisation, but cannot be categorised in one of the three roles above? Yes

- ○ No
- ○

B.16.1. Name of the role

B.16.2. Short description of the role

B.16.3. Which of the following statements are true about this role in the organisation?We have people

- ☐ working in this role
- ☐ We do not have people working in this role
- ☐ We need (extra) people in this role now
- ☐ We expect to need (extra) people in this role within three years
- ☐ We do not need (extra) people in
- ☐ this role I don't know

B.16.3.1 How will your organisation solve the need for (extra) people in this role?

- ☐ We will train current staff
- ☐ We will hire new staff with the right skills

B.17. Do you have any other relevant information on digital sustainability roles and the demand for them within your organisation?

C. Skills for digital sustainability roles in the organisation

People working in digital sustainability roles need several skills to fulfil their role.

In this survey, we are particularly interested in the **skills that relate to digitalization for sustainability,** wher e digital technologies support environmentally and socially sustainable development.

Since little is yet known about the specific skills in this area, ALL your answers to these questions are an important input for us to further map this emerging area. Feel free to provide as much information that you want in the open fields.

The main question is: besides general IT-related skills and organisation-related skills, **what specific additional or other skills does a professional in a digital sustainability role need other than a "normal" digital/ IT professional?**

The questions below are about these additional extra or other skills needs for the people in digital sustainability roles.

C.1. What **sustainability related skills and knowledge** do **digital/ IT professionals** need in your organisation so they can provide digital solutions for sustainability challenges?

Indicate the importance of the following areas:

NOTE - This list below is far from exhaustive, so please use the open field in the next questions to provide more information on skills.

	Not relevant	A bit relevant	Relevant	Very relevant	Highly relevant
Laws, regulations and standards related to digital sustainability	○	○	○	○	○
Sustainable Development Goals (SDGs)	○	○	○	○	○
Social inclusion and gender equality	○	○	○	○	○
Corporate Social Responsibility (CSR) policy and reporting	○	○	○	○	○
Environmental, Social and Governance (ESG) reporting	○	○	○	○	○
Circular business models and economy	○	○	○	○	○
Smart and green cities	○	○	○	○	○
Farm to fork strategies	○	○	○	○	○
Carbon data modelling and scenario mapping	○	○	○	○	○
Waste prevention/ minimisation	○	○	○	○	○
Energy efficiency	○	○	○	○	○
ICT for Development (ICT4D)	○	○	○	○	○
Sustainable IT operation and development	○	○	○	○	○
ICT energy consumption and carbon footprint	○	○	○	○	○

C.2. Do you have any additional clarifications/ comments regarding your above answers?

C.3. Are there any other sustainability related skills and knowledge areas that are relevant for digital/ IT professionals in your organisation?

C.4. How relevant are the following **more general sustainability competences** for the people in digital sustainability roles in your organisation?

For short explanations of these competences, press the question mark.

General Sustainability Competences:

1. **Valuing sustainability** - Identifies, maps, specifies, negotiates, applies and reconciles these values; reflects on personal values, supports fairness, equity and justice, promotes nature
2. **Having a holistic systems view** - Systems thinking: understands interaction of different domains (environmental, economic, social, cultural), scales (local, global) and impacts in the short term and long term
3. **Envisioning sustainable futures** - Envisions and anticipates sustainable future states by developing scenarios, simulations, forecasts, and visions
4. **Problem framing** - Formulates current or potential challenges as sustainability problem in terms of difficulty, people involved, time and geographical scope, to identify suitable approaches to address these problems
5. **Strategic thinking** - Identifies needed steps and constructs strategies (action plans) for interventions and transformations toward sustainability.
6. **Implementing flexibly and adaptably** - Adapts to change while implementing sustainability action plans and managing transitions and challenges, making decisions under uncertainty and ambiguity
7. **Political engagement** - Navigates and mobilises the political system; identifies political responsibility and accountability
8. **Stakeholder engagement** - Involves diverse stakeholders in collective action to achieve sustainability; creates transparent, inclusive and community-driven processes
9. **Acting sustainably as a person** - Recognises own potential for sustainability; having a willingness to act for the community and the planet
10. **Protecting own personal boundaries** - Protects one's own personal boundaries to avoid personal health challenges and burnout, in advancing sustainability transformations through resilience-oriented self-care

Based on:

- *GreenComp (Bianchi, G., Pisiotis, U., Cabrera Giraldez, M. GreenComp – The European sustainability competence framework. Bacigalupo, M., Punie, Y. (editors), EUR 30955 EN, Publications Office of the European Union, Luxembourg, 2022; ISBN 978-92-7646485-3, doi:10.2760/13286, JRC128040)*
- *The Unified framework of competencies for advancing sustainability transformations (Redman A. and Wiek A. (2021). Competencies for Advancing Transformations Towards Sustainability. Front. Educ. 6:785163. doi: 10.3389/feduc. 2021.785163)*

	Not relevant	A bit relevant	Relevant	Very relevant	Highly relevant
1. Valuing sustainability	○	○	○	○	○
2. Having a holistic systems view	○	○	○	○	○
3. Envisioning sustainable futures					
(develops vision, scenarios, forecasts, etc.)	○	○	○	○	○
4. Problem framing (in terms of difficulty, resources etc.)	○	○	○	○	○
5. Strategic thinking (plans action towards sustainability)	○	○	○	○	○
6. Implementing flexibly (adapts to change, deals with ambiguity)	○	○	○	○	○
7. Political engagement	○	○	○	○	○
8. Stakeholder engagement	○	○	○	○	○
9. Acting sustainably as a person	○	○	○	○	○
10. Protecting own personal boundaries (self-care)	○	○	○	○	○

C.5. How relevant are the following transversal/ soft competences for the people in digital sustainability roles in your organisation?

For short explanations of these competences, press the question mark.

Transversal/ soft competences:

1. **Team work** - Collaborates in interdisciplinary and professional teams
2. **Critical thinking** - Assesses information and arguments, identifies assumptions, dares to challenge the status quo
3. **Exploratory thinking** - Explores and links different disciplines, using creativity and experimentation with novel ideas or methods
4. **Willingness to learn** - Realises personal development, keeping an open mind and exercising self-reflection

Based on:

- *GreenComp (Bianchi, G., Pisiotis, U., Cabrera Giraldez, M. GreenComp – The European sustainability competence framework. Bacigalupo, M., Punie, Y. (editors), EUR 30955 EN, Publications Office of the European Union, Luxembourg, 2022; ISBN 978-92-7646485-3, doi:10.2760/13286, JRC128040)*
- *The Unified framework of competencies for advancing sustainability transformations (Redman A. and Wiek A. (2021). Competencies for Advancing Transformations Towards Sustainability. Front. Educ. 6:785163. doi: 10.3389/feduc. 2021.785163)*
- *ESCO/EQF expert group on transversal skills and competences (2021), Towards a structured and consistent terminology on transversal skills and competences.*

	Not relevant	A bit relevant	Relevant	Very relevant	Highly relevant
1. Team work	○	○	○	○	○
2. Critical thinking	○	○	○	○	○
3. Exploratory thinking	○	○	○	○	○
4. Willingness to learn	○	○	○	○	○

C.6. Is there a need for other soft/ transversal skills for people in digital sustainability roles in the organisation?

- ○ Yes
- ○ No

C.6.1. What is/are other soft/ transversal skill(s) for people in digital sustainability roles?

C.7. Do you have any other relevant information on skills related to digital sustainability professionals and the demand for them within your organisation?

D. Questions on training and education

*D.1. Is there a need for training of personnel in digital sustainability roles within your organisation?

- ◯ Yes
- ◯ No

D.1.1. What are the main reasons for having to train personnel in digital sustainability roles?

- ☐ They don't have the right skills when starting the job
- ☐ New (technological) developments ask for new skills
- ☐ New business processes require new skills
- ☐ Clients (internal and/or external) ask for specific skills
- ☐ The organisation is switching infrastructure (e.g. cloud; open
- ☐ source) Other

D.1.1.1. What is/ are other reason(s) for having to train personnel in digital sustainability roles?

*D.2. Is there a backlog in training of personnel in digital sustainability roles within your organisation?

- ◯ Yes
- ◯ No

D.2.1. What are the main reasons for the backlog in training of personnel in digital sustainability roles?

- ☐ The people in these roles don't have time for training
- ☐ The organisation doesn't have time to organise training
- ☐ The people in these roles are resisting training
- ☐ The organisation doesn't have people to train them
- ☐ There is no (external) training available for the required skill(s)
- ☐ Training is too
- ☐ expensive Other

D.2.1.1. For which skill(s) is no training available?

D.2.1.2. What is/ are other reason(s) for the backlog in training of personnel in digital sustainability roles?

D.3. How important are the following **training strategies** for personnel in digital sustainability roles within your organisation?

	Some importance	Important	Very important	*Not relevant*
Upskill own ICT personnel	○	○	○	○
Reskill own non-ICT personnel	○	○	○	○
Hire people with already the right skills	○	○	○	○
Hire people and train them	○	○	○	○
On the job coaching and training	○	○	○	○
In-company training by own staff	○	○	○	○
In-company training by external provider	○	○	○	○
External training	○	○	○	○

D.4. Are there specific reasons why training is organised in this way within your organisation?

D.5. How important are the following kinds of qualification when hiring people in digital sustainability roles?

	Some importance	Important	Very important	*Not relevant*
Certifications relevant for the role	○	○	○	○
Formal professional education relevant for the role	○	○	○	○
Formal professional education in any field	○	○	○	○
Bachelor/ master degree relevant for the role	○	○	○	○
Bachelor/ master degree in any field	○	○	○	○

D.6. Do you have any other relevant information on training of personnel in digital sustainability roles and the demand for training within your organisation?

Register and submit

*Do you want to **register** for project updates and information including receiving the Digital Sustainability Needs Analysis?
(Please find our privacy statement **here**)

- Yes
- No

Would you be interested in participating in an online expert panel meeting where the roles and skills will be discussed further?

- Yes
- No

What is the name of your organisation?

First name

*Surname

*Email address

* ☐ By checking this box I agree I want to receive news and updates on the Digital4Sustainability project, and that I can withdraw my consent at any time.

D2.1.Annex.E analysis of job vacancies

5.1 Approach

The analysis of vacancies provided insight into the current demand for digital for sustainability roles and skills. The vacancy analysis was carried out on the basis of manually collecting vacancies. There were a number of reasons for this. Most importantly, there are several major methodological limitations to the automated approach, such as the fact that most of these tools can only process English-language job ads. Moreover, the project does not provide budget to hire an external organisation to do this via crawling/ scraping.

The main focus was on the roles that resulted from the initial desk research. Additionally, any other role directly related to a digital solution for a sustainability challenge was considered relevant. The data were collected using a qualitative approach that involved manually checking whether a vacancy was really about digital for sustainability and what skills were actually relevant in those vacancies. This ensured that the right vacancies were analysed and that vacancies in the national language could be included in the study. A template was used to collect the data. The analysis of the data provided an overview of the most commonly found roles and skills in terms of descriptive statistics.

5.2 Results

It was discussed in the methodology that the job vacancy scraping should be done manually, so just looking for job postings by searching job portals. This process led to 164 job vacancies in twelve countries.

Besides this, an experiment was conducted in one country whether it was possible to scrape the job vacancies automatically using tools that are also used and proven valid for established fields. This led to 146 potential vacancies of which after first screening only 19 turned out to potentially relevant. After further screening this was reduced to two vacancies directly related to digital for sustainability and seven others that are potentially or partly related to it. This confirmed the

correctness of our starting point that in an emerging field like this, it is not (yet) possible to successfully implement automated AI powered scraping tools.

The original list of job vacancies was again analysed on relevance which again led to a reduction of the dataset ending up with 117 job vacancies to be analysed in depth. These vacancies were published between 20 May and 23 July in the thirteen consortium countries.

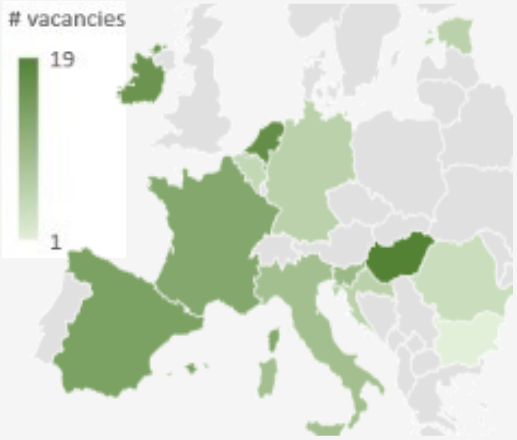


Figure 51 Job vacancies in countries

A more important statistic in this context is that 71% of the job vacancies are positions in large organisations. This is a disproportional amount of job vacancies, since only since only 0,2% of the organisations in the EU are large organisations[11]. This can be explained by the fact that job vacancies are per definition for jobs which is different from roles. A role can be fulfilled by a person in a organisation who also has other roles, which will logically be more the case in smaller organisations. To have a specific job for a digital for sustainability role, will sooner be ~~in~~ the case in larger organisations.

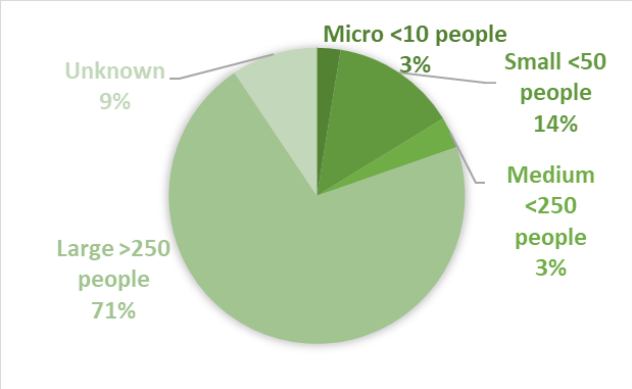


Figure 52 Organisation sizes of job vacancies

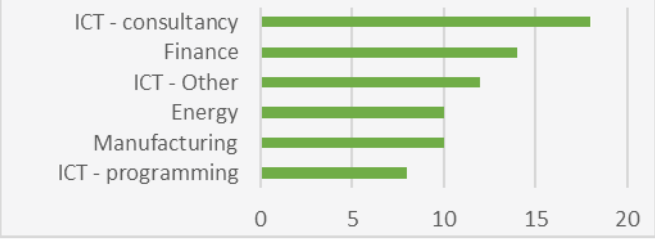


Figure 53 Sectors of job vacancies

Most of the job vacancies are in ICT organisations (32%) when looking at the sectors that the organisations are in. Besides ICT also the financial, energy, and the manufacturing sector are represented well. All other sectors only had a few, one, or even no vacancies. For example the healthcare sector, but also the water and the waste sector did not have any digital for sustainability vacancies in the time frame of this study.

[11] Eurostat. (2023, December 12). Large businesses generated half of EU's net turnover. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20231212-1

5.3 Main findings

Most of the analysed digital for sustainability job vacancies are in the main area of management consultancy (59%) while jobs in the areas of data processing & analysis (25%) and development & operations (16%) are less advertised. This is also visible in the specific roles that the vacancies are related to. The digital sustainability consultant and manager are by far the roles most asked for in job vacancies. From the other areas the sustainability data analyst and the software developer for sustainability are the roles that appear the most in job vacancies. Other roles appear less often, but each role is still asked for in about 4 to 5 % of the vacancies, except for the sustainability technical expert that could only be linked to one vacancy. There are only five vacancies that could not be categorised in the predefined roles, of which three being general supporting internships. This confirms that the preselected roles are covering the current market demand represented in job vacancies.

Figure 54 Roles asked for in job vacancies

The job vacancies are distributed rather evenly when it comes to the job level, with around twenty percent on entry/ junior level and on senior level. The intermediate level is responsible for almost thirty percent of vacancies, with almost a third of the vacancies for which it is not clear. Looking at the requested amount of experience in only three cases more than 10 years is needed. The other vacancies are more or less equally distributed between less than 3 years and 3 to 10 years of required experience. The most dominant requested educational level is by far bachelor level (59%) followed by master level (22%).

The analysis of the content of the job vacancy shows first of all that at the moment ESG is the most important topic. It is the top mentioned word in the job title (22%), and the top sustainability skills are the skills related to ESG. Also, it is one of the top requested knowledge areas (16%) and the one most mentioned tasks (27%) .

The second important topic is anything to do with data. 13% of the job titles include the word "data" and in the category digital/ ICT skills data related skills are the most present (37%). Also, it tops the knowledge areas mentioned in job vacancies (19%).

It is also interesting to mention that a lot of the job vacancies are about management (27% of the job titles included "manager" or "management") and managing was mentioned the most as task (38%). Related to that, also consultant is mentioned often (21%) in the job title, which means that at least 50% of the roles are directly management & consultancy roles.

Finally, the transversal (soft) professionals skills that are asked for are mainly communication (50%) and teamwork (35%).

5.4 Analysis

The three identified main categories of roles were all present in the analysed job vacancies. The dominant category is the digital for sustainability management & consultancy roles. (59%). Both the data processing & analysis group (25%) and development & operations (16%) are appearing less. This indicates that jobs specifically advertised as being digital roles focusing on sustainability are mainly on management level and that this aspect is at least less advertised in job vacancies for more technical roles.

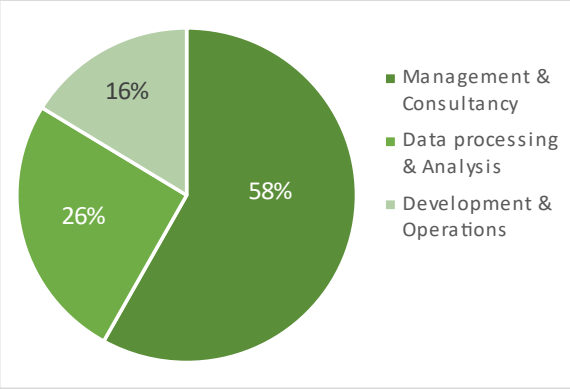


Figure 55 Role groups present in vacancies

There are three management & consultancy roles identified of which both digital sustainability manager (24% of the total vacancies) and consultant (28%) appear a lot in job vacancies. The manager vacancies were more in large organisations than the overall sample, with only one medium, two small, and no micro organisations looking for this role. The role was asked in all kinds of sectors with sometimes small an overrepresentation like for example 50% of the vacancies in the manufacturing sector are for this manager role. The consultancy role is mainly asked for in ICT-organisations (55% of those vacancies) and then mainly the ICT-consultancies. 78% of the vacancies of ICT-consultancies are for the role of digital sustainability consultant. This can be explained by the fact that ICT-consultancies are hiring these consultants to advice their clients on this topic. The digital sustainability lead is less frequently asked for in job vacancies, which van be explained by two things. Firstly, it will rarely happen that

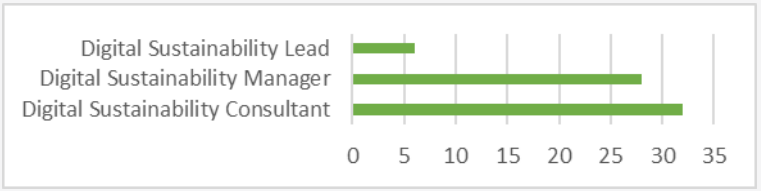


Figure 56 management & consultancy roles in vacancies

organisations need or want more than one lead, so this limits the amount of vacancies. Secondly, it is a role which is typically fulfilled by somebody that people in the organisation already know and trust. It is therefore logical that most organisations want to fulfil this role internally. It should also not come as a surprise that all vacancies for leads are from large organisations.

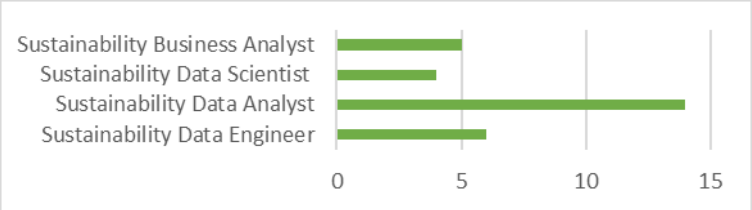


Figure 57 Data processing & analysis roles in vacancies

A more detailed look at the data processing & analysis roles show that the sustainability data analysist is the most needed role in that category. The other roles are currently less in demand according to the job vacancies.

Finally, the development and operations roles show big differences between the roles. Software developers for sustainability are appearing the most in job vacancies, but technical specialists with a focus on sustainability are almost totally not in demand. The sustainability solution designer is in the middle between the two other roles looking at the number of job vacancies.

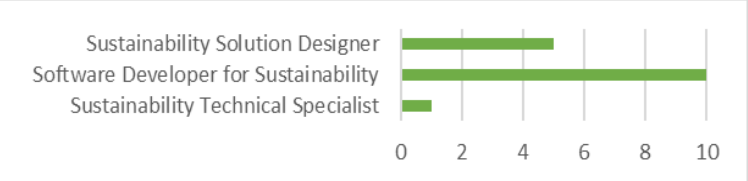


Figure 58 Development & operations roles in vacancies

The job titles provide a first insight in the details of how the roles are translated in specific jobs in these vacancies. Only 45% of the job titles directly include the word “sustainability” itself, with other titles focusing more on either one aspect of sustainability or even without direct reference to (an aspect of) sustainability. 22% of the vacancies contain the word “ESG” which means that the job is certainly focused on ESG reporting ranging from data analysis to reporting itself. The word “climate” is in the title of 9% of the vacancies.

5.5 Overview of analysed job vacancies

Role profile	Size comp.	Sector comp.	Job title	Level job	Educational level	Country of vacancy
[1a] Digital Sustainability Lead	Large >250 people	Energy	Global Lead Buyer IT & Digital Services H/F	Senior	EQF 7, master	France
[1a] Digital Sustainability Lead	Large >250 people	ICT - consultancy	Lead Numérique Responsable Right Tech green IT (H/F) (Digital Lead Right Tech green IT Manager (M/F))	Senior	Not specified	France
[1a] Digital Sustainability Lead	Large >250 people	Agriculture	ESG Reporting Operations Lead	Senior	EQF 6, bachelor	Hungary
[1a] Digital Sustainability Lead	Large >250 people	Manufacturing	Group Decarbonisation Lead	Multiple	EQF 6, bachelor	Ireland
[1a] Digital Sustainability Lead	Large >250 people	Governmental organisation	Chief Sustainability Officer: Leading Sustainability	Not clear	EQF 6, bachelor	Spain
[1a] Digital Sustainability Lead	Not traceable	OTHER	Sustainable Value Chain Specialist	Senior	Not specified	Netherlands
[1b] Digital Sustainability Manager	Large >250 people	ICT - OTHER	ESG manager	Senior	EQF 7, master	Croatia
[1b] Digital Sustainability Manager	Large >250 people	Finance	ESG specialist	Intermediate	EQF 7, master	Croatia
[1b] Digital Sustainability Manager	Large >250 people	OTHER	Energy expert	Multiple	EQF 7, master	Estonia
[1b] Digital Sustainability Manager	Large >250 people	ICT - consultancy	solution architect, sustainability	Senior	EQF 6, bachelor	Estonia
[1b] Digital Sustainability Manager	Large >250 people	Governmental organisation	Chargé.e de Projets Energie (H/F) (Energy Project Manager (M/F))	Intermediate	EQF 7, master	France
[1b] Digital Sustainability Manager	Large >250 people	Energy	Chargé(e) de développement photovoltaïque (Photovoltaic development manager)	Entry/ junior	EQF 7, master	France
[1b] Digital Sustainability Manager	Large >250 people	ICT - data processing, hosting etc.	Senior Manager, Sustainable Software Engineer Advocate	Senior	Not specified	France
[1b] Digital Sustainability Manager	Large >250 people	ICT - OTHER	Sustainability Engineer and Manager	Senior	EQF 6, bachelor	Germany

[1b] Digital Sustainability Manager	Large >250 people	ICT - OTHER	*Sustainability Manager Circular Economy*	Intermediate	EQF 6, bachelor	Germany
[1b] Digital Sustainability Manager	Large >250 people	Energy	Sustainability Reporting Team Lead	Intermediate	EQF 6, bachelor	Hungary
[1b] Digital Sustainability Manager	Large >250 people	OTHER	Manager - Sustainability	Intermediate	EQF 6, bachelor	Hungary
[1b] Digital Sustainability Manager	Large >250 people	Transportation & storage	Junior Sustainability Manager	Entry/ junior	EQF 6, bachelor	Hungary
[1b] Digital Sustainability Manager	Large >250 people	Manufacturing	Sustainability and IT Process Global Procurement manager	Intermediate	Not specified	Hungary
[1b] Digital Sustainability Manager	Large >250 people	Manufacturing	EU Carbon Compliance Project Manager - Supply Chain (EU-based position)	Intermediate	EQF 6, bachelor	Hungary
[1b] Digital Sustainability Manager	Large >250 people	Construction	Sustainability Manager	Not clear	EQF 6, bachelor	Ireland
[1b] Digital Sustainability Manager	Large >250 people	Tourism	Sustainability Manager	Not clear	EQF 7, master	Ireland
[1b] Digital Sustainability Manager	Large >250 people	ICT - consultancy	ESG Strategist / Program Mgr, AWS Sustainability	Not clear	EQF 8, post-master	Ireland
[1b] Digital Sustainability Manager	Large >250 people	ICT - programming	Sustainability Officer	Multiple	EQF 6, bachelor	Ireland
[1b] Digital Sustainability Manager	Large >250 people	Finance	Tech Lead Sustainable Living	Not clear	EQF 6, bachelor	Netherlands
[1b] Digital Sustainability Manager	Large >250 people	Manufacturing	Sustainability Analyst	Not clear	EQF 6, bachelor	Netherlands
[1b] Digital Sustainability Manager	Large >250 people	Finance	Sustainability Manager	Intermediate	EQF 6, bachelor	Romania
[1b] Digital Sustainability Manager	Large >250 people	Agriculture	Certification and Sustainability Manager	Intermediate	EQF 6, bachelor	Spain
[1b] Digital Sustainability Manager	Large >250 people	Manufacturing	Sustainability Specialist	Intermediate	EQF 6, bachelor	Spain
[1b] Digital Sustainability Manager	Medium <250 people	Manufacturing	Environmental Management System Manager	Senior	EQF 6, bachelor	Slovenia
[1b] Digital Sustainability Manager	Not traceable		Freelance Sustainable ICT Program Manager	Not clear	Not specified	Belgium
[1b] Digital Sustainability Manager	Not traceable	OTHER	ESG Product Manager	Not clear	EQF 6, bachelor	Hungary

[1b] Digital Sustainability Manager	Small <50 people	OTHER	sustainability and Innovation Manager	Senior	EQF 6, bachelor	Germany
[1b] Digital Sustainability Manager	Small <50 people	ICT - OTHER	Project Manager - Sustainable agriculture supply chains	Senior	Not specified	Germany
[1c] Digital Sustainability Consultant	Large >250 people	OTHER	ESG Data & Reporting Consultant	Not clear	Not specified	Belgium
[1c] Digital Sustainability Consultant	Large >250 people	Finance	Climate Change and Sustainability Services Senior	Senior	EQF 7, master	Croatia
[1c] Digital Sustainability Consultant	Large >250 people	ICT - OTHER	Managing Consultant Green IT / IT Sustainability HF	Not clear	EQF 7, master	France
[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	Consultant senior en Transformation Green IT (Senior Consultant in Green IT Transformation M/F)	Intermediate	EQF 7, master	France
[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	ESG Consultant Internship	Entry/ junior	EQF 7, master	France
[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	Consultant en Transformation Digitale & Innovation H/F	Intermediate	EQF 7, master	France
[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	Consultant on Value Chain Sustainability	Entry/ junior	EQF 7, master	France
[1c] Digital Sustainability Consultant	Large >250 people	ICT - OTHER	Manager Sustainability & Climate / Sustainability Advisor	Senior	EQF 6, bachelor	Germany
[1c] Digital Sustainability Consultant	Large >250 people	OTHER	Senior Advisor - ESG Advisory Climate Change and Sustainability Services	Intermediate	EQF 6, bachelor	Hungary
[1c] Digital Sustainability Consultant	Large >250 people	OTHER	Senior Consultant - Sustainability	Intermediate	EQF 6, bachelor	Hungary
[1c] Digital Sustainability Consultant	Large >250 people	OTHER	Sustainability - Senior Consultant/Assistant Manager/Manager/Senior Manager	Multiple	EQF 6, bachelor	Ireland
[1c] Digital Sustainability Consultant	Large >250 people	Construction	ESG/ Sustainability Transformation Manager, Hybrid	Multiple	Specified as not relevant	Ireland
[1c] Digital Sustainability Consultant	Large >250 people	Finance	Sustainability Transformation Manager	Multiple	EQF 6, bachelor	Ireland
[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	Technology Consulting (Sustainability) - Solution Architect - Senior Manager	Multiple	Not specified	Ireland
[1c] Digital Sustainability Consultant	Large >250 people	ICT - OTHER	UKI TC - Sustainability Technology Director	Multiple	Not specified	Ireland

[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	ESG/ Sustainability Transformation Manager, Hybrid	Multiple	EQF 6, bachelor	Ireland
[1c] Digital Sustainability Consultant	Large >250 people	OTHER	Manager ESG Tech&Data	Not clear	EQF 7, master	Netherlands
[1c] Digital Sustainability Consultant	Large >250 people	OTHER	Sustainability Advisor IT & Data	Senior	Not specified	Netherlands
[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	Digital Twin Consultant	Intermediate	Not specified	Romania
[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	Consultant in Risk Advisory I Regulatory & Compliance	Intermediate	EQF 6, bachelor	Slovenia
[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	Junior Adviser in the Climate Change and Sustainability Unit (m/f)	Entry/ junior	EQF 6, bachelor	Slovenia
[1c] Digital Sustainability Consultant	Large >250 people	ICT - web portals/ platforms	Associate Delivery Consultant - Sustainability Technology Expert Labs	Not clear	Not specified	Spain
[1c] Digital Sustainability Consultant	Large >250 people	ICT - consultancy	Junior Climate Change and Sustainability Consultant	Entry/ junior	EQF 7, master	Spain
[1c] Digital Sustainability Consultant	Large >250 people	Energy	Industry 4.0 Consultant	Intermediate	EQF 6, bachelor	Spain
[1c] Digital Sustainability Consultant	Medium <250 people	ICT - consultancy	Consultant(e) Environnement - Analyse du Cycle de Vie et Bilan Carbone (alternance) F/H (Environmental Consultant - Life Cycle Analysis and Carbon Balance (alternation) F/M))	Entry/ junior	EQF 6, bachelor	France
[1c] Digital Sustainability Consultant	Small <50 people	Finance	ESG consultant	Intermediate	EQF 7, master	Croatia
[1c] Digital Sustainability Consultant	Small <50 people	ICT - consultancy	CONSULTANT.E ÉNERGIE/CLIMAT (STAGE) (ENERGY/CLIMATE CONSULTANT)	Entry/ junior	EQF 6, bachelor	France
[1c] Digital Sustainability Consultant	Small <50 people	Energy	Energy Industry Consultant	Senior	EQF 7, master	Germany
[1c] Digital Sustainability Consultant	Small <50 people	ICT - web portals/ platforms	ESG specialist	Intermediate	EQF 6, bachelor	Slovenia
[1c] Digital Sustainability Consultant	Small <50 people	OTHER	Junior Process Consultant	Intermediate	EQF 6, bachelor	Spain
[1c] Digital Sustainability Consultant	Small <50 people	OTHER	ESG Consultant for technology	Intermediate	EQF 6, bachelor	Spain

[1c] Digital Sustainability Consultant	Small <50 people	ICT - consultancy	ESG Consultant for technology	Intermediate	EQF 6, bachelor	Spain
[1c] Digital Sustainability Consultant	Not traceable	Manufacturing	Sustainability Advisor	Not clear	EQF 6, bachelor	Ireland
[2a] Sustainability Business Analyst	Large >250 people	OTHER	ESG consultant	Senior	EQF 7, master	Croatia
[2a] Sustainability Business Analyst	Large >250 people	OTHER	Senior Consultant / Manager | Risk & Regulatory Advisory| Climate & Environmental risks management| Sustainable finance| ESG strategy	Senior	EQF 6, bachelor	Croatia
[2a] Sustainability Business Analyst	Large >250 people	OTHER	Manager Digital Transformation - Digital Twin of an organisation	Not clear	EQF 6, bachelor	Netherlands
[2a] Sustainability Business Analyst	Large >250 people	Finance	ESG Business Analyst	Not clear	Not specified	Netherlands
[2a] Sustainability Business Analyst	Small <50 people	OTHER	Senior Sustainability Technician	Senior	EQF 8, post-master	Spain
[2b] Sustainability Data Scientist	Large >250 people	Finance	Climate Research Data Scientist	Entry/ junior	Not specified	Hungary
[2b] Sustainability Data Scientist	Large >250 people	OTHER	Data scientist sustainable mobility	Not clear	EQF 7, master	Netherlands
[2b] Sustainability Data Scientist	Not traceable	OTHER	Climate Research Data Scientist	Not clear	Not specified	Hungary
[2b] Sustainability Data Scientist	Small <50 people	OTHER	Data Science Innovator	Multiple	EQF 7, master	Estonia
[2c] Sustainability Data Analyst	Large >250 people	Finance	ESG Controller Senior Analyst	Senior	EQF 6, bachelor	Hungary
[2c] Sustainability Data Analyst	Large >250 people	OTHER	Sustainability Performance & Analytics Expert	Not clear	EQF 7, master	Belgium
[2c] Sustainability Data Analyst	Large >250 people	Manufacturing	Analyst, Enterprise Finance Solutions	Multiple	EQF 7, master	Estonia
[2c] Sustainability Data Analyst	Large >250 people	Energy	IT SYSTEMS ANALYST (ELECTRIC VEHICLE CHARGING) (F/M/D)	Intermediate	EQF 6, bachelor	Estonia
[2c] Sustainability Data Analyst	Large >250 people	Finance	Sustainable Solutions Collaborative Analyst	Entry/ junior	EQF 6, bachelor	Hungary
[2c] Sustainability Data Analyst	Large >250 people	Finance	Analyst, Sustainable Investing Research and Analytics	Intermediate	EQF 6, bachelor	Hungary

[2c] Sustainability Data Analyst	Large >250 people	OTHER	Senior data analyst ESG	Senior	EQF 6, bachelor	Netherlands
[2c] Sustainability Data Analyst	Large >250 people	Finance	ESG Data Analyst	Not clear	EQF 6, bachelor	Netherlands
[2c] Sustainability Data Analyst	Large >250 people	Finance	Analyst in Business Monitoring, Business Support Sector	Intermediate	EQF 6, bachelor	Slovenia
[2c] Sustainability Data Analyst	Large >250 people	OTHER	Senior Environment and Sustainability Technician	Intermediate	EQF 6, bachelor	Spain
[2c] Sustainability Data Analyst	Medium <250 people	ICT - programming	Data Analyst Sustainability	Entry/ junior	EQF 6, bachelor	Belgium
[2c] Sustainability Data Analyst	Not traceable		Data analyst ESG	Not clear	Not specified	Netherlands
[2c] Sustainability Data Analyst	Small <50 people	OTHER	ESG Analyst	Not clear	EQF 6, bachelor	Netherlands
[2c] Sustainability Data Analyst	Small <50 people	OTHER	Sustainability & Big Data Manager	Not clear	EQF 6, bachelor	Netherlands
[2d] Sustainability Data Engineer	Large >250 people	ICT - OTHER	Sustainability Data Engineer	Entry/ junior	EQF 4/5, VET	Belgium
[2d] Sustainability Data Engineer	Large >250 people	Finance	Senior Consultant - Waste Management, Circular Economy	Entry/ junior	EQF 7, master	Hungary
[2d] Sustainability Data Engineer	Large >250 people	Energy	Environmental Compliance Analyst Intern	Entry/ junior	EQF 6, bachelor	Hungary
[2d] Sustainability Data Engineer	Large >250 people	OTHER	Sustainability Solutions Analyst	Intermediate	EQF 6, bachelor	Hungary
[2d] Sustainability Data Engineer	Large >250 people	ICT - OTHER	Climate Data Engineer	Entry/ junior	EQF 6, bachelor	Netherlands
[2d] Sustainability Data Engineer	Medium <250 people	Finance	ESG data manager	Not clear	EQF 6, bachelor	Netherlands
[3a] Sustainability Solution Designer	Large >250 people	OTHER	Infrastructure Architect	Senior	EQF 6, bachelor	Estonia
[3a] Sustainability Solution Designer	Large >250 people	Manufacturing	Internship in Digital Sustainability	Entry/ junior	EQF 6, bachelor	Netherlands
[3a] Sustainability Solution Designer	Large >250 people	Facility services	Director-Sustainability Expert – Energy Transition Services.		EQF 6, bachelor	Spain
[3a] Sustainability Solution Designer	Micro <10 people	OTHER	Head of Sustainability – BDO Ireland	Senior	EQF 6, bachelor	Ireland

[3a] Sustainability Solution Designer	Small <50 people	ICT - consultancy	Sustainability & ESG - Manager and Director Level roles	Multiple	EQF 7, master	Ireland
[3b] Software Developer for Sustainability	Large >250 people	ICT - programming	Software Developer for SAP Sustainability solution: SAP S/4HANA for product compliance	Intermediate	EQF 6, bachelor	Bulgaria
[3b] Software Developer for Sustainability	Large >250 people	ICT - consultancy	STAGE - Ingénieur informatique Green IT (Internship - Green IT engineer)	Entry/ junior	EQF 6, bachelor	France
[3b] Software Developer for Sustainability	Large >250 people	OTHER	Internship | Digital product passports for Industry 4.0	Entry/ junior	EQF 7, master	Netherlands
[3b] Software Developer for Sustainability	Large >250 people	Construction	Senior Sustainability Engineer	Entry/ junior	EQF 6, bachelor	Romania
[3b] Software Developer for Sustainability	Large >250 people	ICT - programming	Technical Support Engineer- Maternity leave replacement	Intermediate		Slovenia
[3b] Software Developer for Sustainability	Large >250 people	ICT - programming	Associate Engineer - Sustainability	Intermediate	EQF 6, bachelor	Slovenia
[3b] Software Developer for Sustainability	Micro <10 people	Energy	Java SE backend - electricity regulation	Intermediate	Not specified	Slovenia
[3b] Software Developer for Sustainability	Micro <10 people	ICT - programming	Application engineer	Intermediate	EQF 6, bachelor	Slovenia
[3b] Software Developer for Sustainability	Small <50 people	ICT - programming	Software Developer for SAP Sustainability Solutions	Not clear	EQF 6, bachelor	Romania
[3b] Software Developer for Sustainability	Small <50 people	ICT - programming	Technical Consultant	Not clear	EQF 6, bachelor	Spain
[3c] Sustainability Technical Specialist	Not traceable	Manufacturing	Packaging Engineer - Sustainability	Intermediate	EQF 6, bachelor	Ireland
OTHER	Large >250 people	ICT - consultancy	Technician specialized in Environment and ESG	Intermediate	EQF 6, bachelor	Spain
OTHER	Not traceable	Manufacturing	Research Chemist Sustainability	Senior	EQF 7, master	Ireland
OTHER	Large >250 people	Energy	Sales Intern - Sustainability	Entry/ junior	EQF 6, bachelor	Hungary
OTHER	Large >250 people	Energy	Sustainability Intern	Entry/ junior	EQF 6, bachelor	Hungary
OTHER	Large >250 people	Energy	Junior in the IT deparmtent	Entry/ junior	EQF 4/5, VET	Slovenia

D2.1.Annex.F Analysis of the supply of education & training

6.1 Approach

The supply side consisted of educational offerings on digital for sustainability skills. The first focus was that the learning programmes are at VET (EQF 4/5) or higher VET (EQF 6/7) level. These learning programmes can be offered by public and private universities, VET providers, training providers, vendors or in-house training departments.

To gain an overview, the current supply was mapped. This was done by extracting information from websites, brochures etc. A template was used to provide the necessary information needed for analysis of every offering. If the information about an offering could not be completed with the available documentation, the provider was approached and asked about the missing information.

The analysis consisted of an overview of the offerings with relevant clustering to provide insight in the supply.

6.2 Results

A total of 157 learning programmes were collected and analysed, spread across the consortium countries. Most of these programmes are offered by public institutes (81%), followed by private providers (18%), and only one percent of the analysed programmes being in company programmes. This can be explained by the fact that information of in company learning programmes is less available. The analysed learning programmes are mainly at master level (66%) with another 23% at bachelor level. Given the nature of the programmes, it is logical that most of them

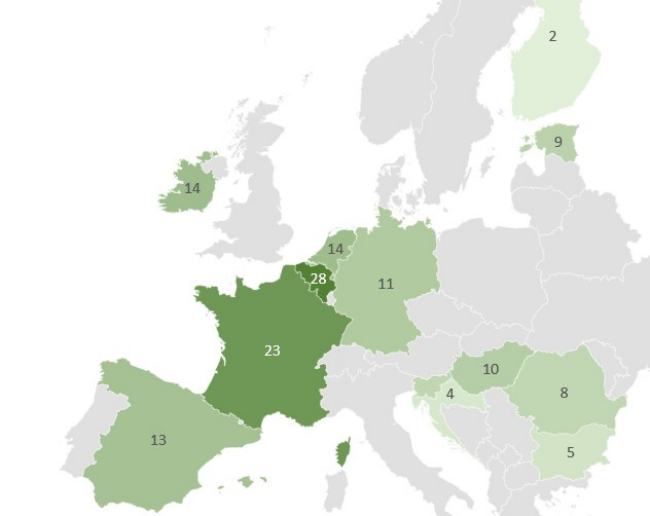


Figure 59 Supply of learning programmes across countries

Co-funded by the European Union

result in a degree (79%) and only some of them with a certificate (15%).

6.3 Main findings

The current supply of learning programmes is for a large part focused on digital for sustainability management & consultancy roles (33%). There is an even larger percentage of learning programmes that does not specifically focus, but covers two or all three of the role areas.

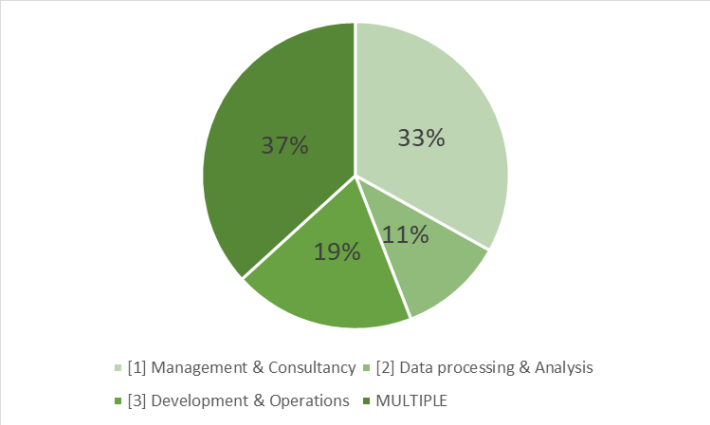


Figure 60 Learning programme focus across role areas

The largest issue at the moment though is that most of the learning programmes are not explicitly about digital for sustainability or the twin transition in general. They are mainly programmes that have a focus on one aspect and then have the other as a kind of add-on in some parts of the programme. Also, programmes are sometimes very specialised, which means that they cover some very specific elements of sustainability and it is unclear whether it is covered more broadly.

There are programmes aimed at educating digital professionals with some attention for sustainability without being explicit about it, like making it part of the title or description of the programme. Also, there are hardly any dedicated learning units in the programmes dedicated to sustainability. These digital professional programmes are in some cases focused on a certain field, like for example agriculture or geoinformatics which are fields that unavoidably should cover aspects of sustainability, but it is not explicitly integrated in the programmes yet.

The other way around there are environmental science programmes that contain implicitly attention to the possibilities of digital solutions like for example a course on geographic information systems, but without having courses on designing, developing, and deploying digital solutions for sustainability goals. The conclusion is that skilling digital sustainability professionals is difficult when somebody wants to do that in one learning programme. It requires at least two programmes with one having the focus on digital and the other on sustainability. This of course limits the potential synergies between both fields, which is going against the twin transition narrative.

Upskilling existing sustainability professionals entails they have to have thorough digital training. The limitation this training usually has is that it does not cover digital for sustainability solutions in particular, which means that professionals should find this out themselves.

There are some specialised, specific programmes that cover digital for sustainability solutions, like for example ICTs in sustainable cities and territories or twin innovation by SMEs in the construction sector. These, mainly short, programmes are very relevant, but have the limitation that it only focuses on one specific aspect of sustainability and related digital solutions.

Finally, there are some courses that help to upskill professionals that deal with digital for sustainability topics, like SME owners. These are courses like ICT tools for sustainability for entrepreneurs.

6.4 Overview of learning programmes analysed

Title learning programme	Relates to which group of roles	Programme specialisation(s)	EQF Level	Recog-nition	Name provider	Country
Master in sustainable Digital Transition and Co-design	Multiple	Understanding new 2.0 social dynamics; ability to manage a design project; ability to analyse technological offerings	EQF7 (master)	Degree	Conservatoire National des Arts et Métiers	France
Master in innovation, management of technology and sustainable development	[1] Management & Consultancy	Understand the cross-disciplinary nature of transformation and innovation processes; assimilate a corporate social responsibility mindset and build a corporate social responsibility strategy; strengthen multi-skilling in the field of sustainable development; develop creative skills and innovative initiatives.	EQF7 (master)	Degree	Université Paris 1 Panthéon Sorbonne	France
Master of Science in Fintech and Digital Sustainability	Multiple	Technical expertise in digitisation and sustainable financial services in every sector of finance	EQF7 (master)	Degree	The American Business School of Paris	France
Master in environmental and solidar transition	[1] Management & Consultancy	Artificial intelligence and digitisation, eco-design and sustainable development, project and transition management	EQF7 (master)	Degree	Green Management School	France
MS and MBA - Bac +4 and Bac+5. MBA Sustainable Management	[1] Management & Consultancy	Develop strategies to protect the environment; Learn data processing and modelling tools to analyse environmental data; Discover specific project management methodologies.	EQF7 (master)	Degree	Digital College	France
M1 + M2 European Digital and Sustainable Business (EDSB)	[1] Management & Consultancy	Recycling systems, renewable energy, data science and artificial intelligence	EQF7 (master)	Degree	EM Strasbourg Business School	France
Masters in economics, data and transition	Multiple	Data analysis	EQF7 (master)	Degree	CY Cergy Paris Universite - Institute of Economics and Management	France
Master in science and technology for agriculture, food and the environment.	[3] Development & Operations	AgroTech, environmental technology	EQF7 (master)	Degree	Université Paris - Est Créteil Var de Marne	France

Master of Engineering and Management of the Environment and Sustainable Development	Multiple		EQF7 (master)	Degree	Université de Technologie Troyes	France
MBA Energy Transition Management	[1] Management & Consultancy	Identify, assess and remedy risks; Manage and contribute to business plans for CSR energy transition projects; Support the implementation of CSR energy transition action plans.	EQF7 (master)	Degree	De Vinci Executive Education	France
Master in Agricultural sciences engineering. Option Data science for agronomy and agri-food	Multiple	Data science, Big Data, agrotech	EQF7 (master)	Degree	L'institut agro Montpellier	France
Master in Green Tech and Sustainable societies	[1] Management & Consultancy	evaluate and design practices, technologies and systems that provide sustainable solutions for communities and organizations	EQF7 (master)	Degree	Burgundy School of Business (BSB Lyon)	France
Master Spécialisé Eco-Innovation et Nouvelles Technologies de l'Energie	Multiple	Eco-energy; eco-innovation; project management; developing sustainable strategies	EQF7 (master)	Degree	ICAM	France
Gestion de projets hydrotechnologie et environnementaux (HYDROPROTECH)		Evaluate the sizing of works, networks and water management or treatment systems, developing a critical and open-minded approach; Develop numerical hydrology models	EQF7 (master)	Degree	Université Côte d'Azur	France
MSC Engineers for smart cities		Examine the challenges of urban development by applying case studies; analyse and critique the urban environment; analyse the strategic and managerial issues raised by the deployment of innovations for digital and sustainable cities.	EQF7 (master)	Degree	Université Côte d'Azur	France
Master Environmental Engineering		Design and implement solutions to prevent, control, or remediate environmental problems, such as air and water pollution, waste management, and climate change.	EQF7 (master)	Degree	Centrale Mediterranée	France
Master in Sustainability and Social Innovation		The Master in Sustainability and Social innovation is designed for current aspiring changemakers to develop the skills and knowledge needed to transform both society and enterprises into more sustainable practices	EQF7 (master)	Degree	HEC Paris	France
Master Engineering and environmental management	Multiple		EQF7 (master)	Degree	MINES Paris-PSL - ISIGE	France

Master Management & Sustainable development	[1] Management & Consultancy		EQF7 (master)	Degree	Le Mans Université	France
Continuing education: Artificial intelligence for sustainable digital development	Multiple			Certificate	ESIEE-IT	France
Continuing education: Green datacenter and energy performance	Multiple			Certificate	ESIEE-IT	France
Continuing education: Smart cities and sustainable innovation	Multiple			Certificate	ESIEE-IT	France
Continuing education: Ecodesign of digital services	Multiple			Certificate	ESIEE-IT	France
TELECOMMUNICATIONS AND COMPUTER TECHNOLOGY	[3] Development & Operations	Telecommunications and Computer Technologies	EQF6 (bachelor)	Degree	New Bulgarian University	Bulgaria
NETWORKING TECHNOLOGIES	[3] Development & Operations	Network Administration Network Programming	EQF6 (bachelor)	Degree	New Bulgarian University	Bulgaria
INNOVATION AND ENTREPRENEURSHIP IN COMPUTER AND COMMUNICATION TECHNOLOGIES	[1] Management & Consultancy	Major: Communication and Computer Engineering Qualification: MSc in Technological Innovation Management in Computer and Communication Engineering	EQF7 (master)	Degree	New Bulgarian University	Bulgaria
IT PROJECT MANAGEMENT	[1] Management & Consultancy	Major: Informatics and Computer Science Qualification: MSc in Information Technology Project Management	EQF7 (master)	Degree	New Bulgarian University	Bulgaria
COMPUTER SCIENCE	[2] Data processing & Analysis	Speciality: МИК010113 Computer Science Professional qualification: Bachelor in Computer Science	EQF6 (bachelor)	Degree	SOFIA UNIVERSITY ST. KLIMENT OHRIDSKI, Faculty of Mathematics and Informatics (FMI)	Bulgaria

INFORMATICS	[2] Data processing & Analysis	Professional area: 4.6. Informatics and Computer Science Speciality: Informatics Professional qualification: Bachelor in Informatics	EQF6 (bachelor)	Degree	SOFIA UNIVERSITY ST. KLIMENT OHRIDSKI, Faculty of Mathematics and Informatics (FMI)	Bulgaria
INFORMATION SYSTEMS	[2] Data processing & Analysis	Professional area: 4.6. Informatics and Computer Science Speciality: МИБ010113 Information Systems Professional qualification: Bachelor in Information Systems	EQF6 (bachelor)	Degree	SOFIA UNIVERSITY ST. KLIMENT OHRIDSKI, Faculty of Mathematics and Informatics (FMI)	Bulgaria
SOFTWARE ENGINEERING	[2] Data processing & Analysis	Professional area: 4.6. Informatics and Computer Science Speciality: МИЕ010113 Software Engineering Professional qualification: Bachelor in Software Engineering	EQF6 (bachelor)	Degree	SOFIA UNIVERSITY ST. KLIMENT OHRIDSKI, Faculty of Mathematics and Informatics (FMI)	Bulgaria
IT SERVICES AND PROJECTS	[1] Management & Consultancy	Professional area: 4.6. Informatics and Computer Science - IT Services and Projects	EQF7 (master)	Degree	SOFIA UNIVERSITY ST. KLIMENT OHRIDSKI, Faculty of Mathematics and Informatics (FMI)	Bulgaria
TECHNOLOGIES FOR KNOWLEDGE AND INNOVATIONS	[1] Management & Consultancy	Professional area: 4.6. Informatics and Computer Science MSC in Informatics - Technologies for Knowledge and Innovations	EQF7 (master)	Degree	SOFIA UNIVERSITY ST. KLIMENT OHRIDSKI, Faculty of Mathematics and Informatics (FMI)	Bulgaria
TECHNOLOGY ENTREPRENEURSHIP AND INNOVATION IN INFORMATION TECHNOLOGY	[1] Management & Consultancy	Professional area: 4.6. Informatics and Computer Science Professional qualification: MSC in Informatics - Technology Entrepreneurship and Innovation in Information Technology	EQF7 (master)	Degree	SOFIA UNIVERSITY ST. KLIMENT OHRIDSKI, Faculty of Mathematics and Informatics (FMI)	Bulgaria
The Technology Governance and Sustainability	[1] Management & Consultancy	The programme specializes in technology governance, innovation, and sustainability. It provides a comprehensive approach to understanding economic development, innovation, and the socio-political frameworks necessary for sustainable transitions.	EQF7 (master)	Degree	Tallinn University of Technology (TalTech)	Estonia

Artficial Intelligence for Sustainable Societies	Multiple	The programme specialises in sustainable societies, AI solutions, participatory design, and citizen engagement. These specialisations are integral parts of the curriculum, designed to address the complex interactions between technology and society.	EQF7 (master)	Degree	Tallinn University, School of Digital Technologies	Estonia
Maritime digital solutinons (Microdegree)	[3] Development & Operations	It integrates maritime technology with digitalisation and innovation to create sustainable solutions for the maritime industry. The focus is on developing advanced technologies and digital methods to improve efficiency and sustainability in maritime operations.	EQF7 (master)	Certificate	Tallinn University of Technology (TalTech)	Estonia
Innovation and Technology Management	[1] Management & Consultancy	The specialisations include integrating ICT solutions into management processes, innovation policy, digital business analysis, and entrepreneurial management.	EQF7 (master)	Degree	University of Tartu	Estonia
Sustainable Digital Life, Sustainable Societies and Digitalisation	[1] Management & Consultancy	The programme specializes in international business, entrepreneurship, and innovation management, providing students with a comprehensive understanding of how to manage innovation in global firms.	EQF7 (master)	Degree	University of Turku, Finland	Finland
Sustainable and Autonomous Systems	[3] Development & Operations	The programme specialises in sustainable autonomous systems, including real-time embedded systems, wireless communication, computer vision, environmental sensing, and sustainable development related to energy harvesting and smart cities.	EQF7 (master)	Degree	University of Vaasa, in collaboration with the University of Oulu.	Finland
Digital Health	[2] Data processing & Analysis	Specialisations include e-health, healthcare data systems, medical imaging, signals, and change management in healthcare.	EQF7 (master)	Degree	Tallinn University of Technology	Estonia
e-coverance technologies and services	[1] Management & Consultancy	The programme specialises in digital transformation, e-governance implementation, cyber security, digital identity management, and interoperability of digital services. These specialisations aim to prepare students to handle the complexities of digital government ecosystems and the technological, legal, and managerial aspects of e-governance	EQF7 (master)	Degree	Tallinn University of Technology (TalTech)	Estonia
Digital Innovation, Transformations and Resilience (microdegree)	[1] Management & Consultancy	na	EQF7 (master)	Certificate	Estonian Business School (EBS)	Estonia

Digital Innovation, Transformations, and Resilience	[1] Management & Consultancy	na	EQF7 (master)	Certificate	Estonian Business School (EBS)	Estonia
Sustainable Industry	[3] Development & Operations	na	EQF7 (master)	Degree	Tallinn University of Technology	Estonia
Master of Smart Operations and Maintenance in Industry	Multiple	Three possible elective tracks: machine, factory, or operations	EQF7 (master)	Degree	KU Leuven	Belgium
Master of Biochemical Engineering Technology	OTHER		EQF7 (master)	Degree	University of Antwerp	Belgium
Technology for Integrated Water Management	[3] Development & Operations	Integrated water management	EQF7 (master)	Degree	University of Antwerp // Antwerp Maritime Academy	Belgium
Master in Environmental Science	[1] Management & Consultancy		EQF7 (master)	Degree	University of Antwerp	Belgium
Sustainable Energy and the Digital Transformation (Specialisation track of master in Sustainable Energy System Management)	Multiple	System Innovation Management or Sustainable Energy and the Digital Transformation	EQF7 (master)	Degree	Howest University of Applied Sciences	Belgium
Bachelor of Industrial Product Design	[3] Development & Operations	Design for industry, for identity or for impact	EQF6 (bachelor)	Degree	Howest University of Applied Sciences	Belgium
Master of Science in Engineering: Energy	OTHER		EQF7 (master)	Degree	KU Leuven	Belgium
European Master of Science in Sustainable Food Systems Engineering, Technology and Business	OTHER		EQF7 (master)	Degree	KU Leuven	Belgium
Master in Data Science - Information Technology	[2] Data processing & Analysis	Data Analysis or Cybesecurity	EQF7 (master)	Degree	UCLouvain	Belgium

Master of Science in Environmental Science and Technology	Multiple	Environmental assessment and management of chemicals, Resource recovery technology, or Urban environmental management	EQF7 (master)	Degree	Ghent University	Belgium
International Master of Science in Sustainable and Innovative Natural Resource Management	[1] Management & Consultancy	Resource Recovery and Sustainable Materials, Circular Societies, Sustainable Processes, Georesource Exploration, or Sustainable Entrepreneurship	EQF7 (master)	Degree	Ghent University	Belgium
International Master of Science in Environmental Technology and Engineering	Multiple		EQF7 (master)	Degree	Ghent University	Belgium
Master of Science in Food Technology	OTHER	Food science and technology or Postharvest and food preservation engineering	EQF7 (master)	Degree	Ghent University	Belgium
Master of Science in electrical engineering (communication and information technology)	[3] Development & Operations		EQF7 (master)	Degree	Ghent University	Belgium
Master of Science in Bioscience Engineering: Sustainable Urban Bioscience ENgineering	OTHER	Focus on environmental challenges in urban environments	EQF7 (master)	Degree	Jointly offered by Ghent University, University of Antwerp, KU Leuven	Belgium
Master of Science of Water Resources Engineering	Multiple	strong focus is put on the use of state-of-the-art numerical simulation tools for integrated water management	EQF7 (master)	Degree	KU Leuven (some courses held at VUB campus)	Belgium
Master in Environmental Bioengineering	Multiple	Option of more specilised profile in Data Science.	EQF7 (master)	Degree	UCLouvain	Belgium
Master in Forest and Natural Areas Engineering	Multiple	Option of more specilised profile in Data Science.	EQF7 (master)		UCLouvain	Belgium
Bachelor of Science in Environmental Technology	OTHER		EQF6 (bachelor)	Degree	Ghent University	Belgium
Master of Science in Electromechanical Engineering Technology	Multiple	Mechatronics or Management	EQF7 (master)	Degree	KU Leuven	Belgium
Masters in Environmental Bioengineering	Multiple		EQF7 (master)	Degree	University of Liège	Belgium

Master of Energy Engineering	Multiple	Energy components or Energy networks	EQF7 (master)	Degree	University of Liège	Belgium
Master of Science in Energy Engineering Technology	Multiple		EQF7 (master)	Degree	Hasselt University	Belgium
Master's In Energy Engineering : Specialist Focus on Energy Production and Usage in Industry	Multiple		EQF7 (master)	Degree	University of Mons	Belgium
Bechelor's in Engineering	OTHER	Chemistry and science of the materials, electricity, IT and management, mechanics, and mines and geology	EQF6 (bachelor)	Degree	Univeristy of Mons	Belgium
Masters in Geology and Mining Engineering	OTHER		EQF7 (master)	Degree	University of Mons	Belgium
Master in Sustainable Innovation & Entrepreneurship	[1] Management & Consultancy		EQF7 (master)	Degree	Antwerp Management School	Belgium
Master in Environmental Science and Management	Multiple	Management of the environment or Environmental science	EQF7 (master)	Degree	Univeristé libre de Bruxelles	Belgium
Mechanical Engineering – Project Oriented Applied Programme	[3] Development & Operations	To provide our graduates with high-quality knowledge that encompasses a solid foundation of understanding and knowledge in the broader field of mechanical engineering..	EQF6 (bachelor)	Diploma	Faculty of Mechanical Engineering, University of Ljubljana	Slovenia
Mechanical Engineering – Research and Development Programme	[3] Development & Operations	e “MECHANICAL ENGINEERING – Research and Development Programme” is to educate mechanical engineers who will become qualified for independent R&D and project-oriented work and generate new knowledge both in the field of mechanical sciences as well as areas that require interdisciplinary integration,	EQF6 (bachelor)		Faculty of Mechanical Engineering, University of Ljubljana	Slovenia
Mechanical Engineering – Research and development Programme	[3] Development & Operations	The basic objective of the master’s study programme of Mechanical Engineering – Research and Development programme is to educate graduates of the first-cycle study programmes in the fields of engineering and science. This objective encompasses training them into experts who will be able to effectively and creatively solve complex research and development problems	EQF7 (master)		Faculty of Mechanical Engineering, University of Ljubljana	Slovenia

Computer and Information Science	[3] Development & Operations	Computer and information science is one of the leading breakthrough areas that have been shaping today's economy, education, culture, administration and other activities. The strident development of computer technology dictates the need for highly qualified personnel capable of developing new computer and information technology and implementing it in innovative environments.	EQF6 (bachelor)	Degree	Faculty of Computer and Information Science, University of Ljubljana	Slovenia
Computer and Information Science	[3] Development & Operations	The course syllabus enables the study to be tailored to students' wishes, motivations, and preferences. Elective content covrs a wide range of fields and technologies, and thus allows for diverse professional specialisation.	EQF7 (master)	Degree	Faculty of Computer and Information Science, University of Ljubljana	Slovenia
CREDIT-BEARING EXTRA-CURRICULAR ACTIVITIES OF THE UNIVERSITY OF MARIBOR IN THE ACADEMIC YEAR 2023/2024	Multiple	A large number of teaching units on green and digital content, as the University of Maribor, within the framework of the Recovery and Resilience Plan (RRP), aims to provide students with to equip students with the knowledge and competences for sustainable development and sustainable lifestyles, and part of this is to strengthening the offer of learning units in the field of digital and green transition. (a unit is 3 ECTS in general)	NOT CLEAR		University of Maribor	Slovenia
COMPUTER SCIENCE AND INFORMATION TECHNOLOGIES	[3] Development & Operations	University study, 180 ECTS, 3 years	EQF6 (bachelor)	Diploma	University of Maribor, Faculty of Electrical Engineering and Computer Science	Slovenia
COMPUTER SCIENCE AND INFORMATION TECHNOLOGIES	[3] Development & Operations	University study, 180 ECTS, 3 years	EQF6 (bachelor)	Diploma	University of Maribor, Faculty of Electrical Engineering and Computer Science	Slovenia
MSc in Environmental Science	[1] Management & Consultancy	Multiple	EQF7 (master)	Degree	Trinity College Dublin	Ireland
Bachelor of Science (Honours) in Architectural Technology	[1] Management & Consultancy	Sustainable Design, Digital Skills,	EQF6 (bachelor)	Degree	Atlantic Technological University (ATU)	Ireland

Higher Diploma in Residential Energy Retrofit Management	[1] Management & Consultancy	Digital Skills, Energy Efficiency Programme, Finance Circular Management	EQF6 (bachelor)	Diploma	Technological University of the Shannon (TUS)	Ireland
Certificate in Energy Conservation and Environmental Services	[1] Management & Consultancy	Circular Economy, Digital Skills, Energy Efficiency programme	EQF7 (master)	Certificate	Atlantic Technological University (ATU)	Ireland
Higher Diploma in Construction Data Capture and Analytics	[1] Management & Consultancy	Building Information, ModellingCircular, EconomyConstruction, Data Capture, Digital Construction	EQF6 (bachelor)	Diploma	Technological University of the Shannon (TUS)	Ireland
B.Sc. (Hons) Construction Management (Add On - Part Time)	[1] Management & Consultancy	Digital Skills, Energy Efficiency Programme, Built Environment, Construction Management	EQF6 (bachelor)	Degree	Technological University of the Shannon (TUS)	Ireland
Postgraduate Certificate in Building Information Modelling (BIM) and Digital Leadership	[1] Management & Consultancy	Building Information Modelling, Digital Leadership	EQF7 (master)	Certificate	Atlantic Technological University (ATU)	Ireland
Higher Diploma in Engineering in Building Information Modelling	[1] Management & Consultancy	Building Information Modelling	EQF6 (bachelor)	Diploma	Atlantic Technological University (ATU)	Ireland
Certificate in Drones for Construction	[1] Management & Consultancy	Digital Skills, Energy Efficiency Programme, Finance Circular Management	EQF5 (associate degree)	Certificate	Technological University of the Shannon (TUS)	Ireland
Bachelor of Science (Honours) in Quantity Surveying and Construction Economics	[1] Management & Consultancy	Building Regulations, Building Services, Construction Technology, Quantity Surveying	EQF6 (bachelor)	Degree	Atlantic Technological University (ATU)	Ireland
Postgraduate Diploma (PGDip) in Science in Built Environment Regulation	[1] Management & Consultancy	BIM, Built Environment, Environment,Regulation Science	EQF7 (master)	Diploma	Atlantic Technological University (ATU)	Ireland
Higher Diploma in Building Information Modelling (BIM)	[1] Management & Consultancy	Building Information Modelling, Digital Skills, Energy Efficiency Management	EQF6 (bachelor)	Diploma	Atlantic Technological University (ATU)	Ireland
Certificate in Residential Energy Retrofit Fabric	[1] Management & Consultancy	Building Fabric Technology, Certificate Compliance, Residential Energy, Retrofit Retrofit Approaches, Retrofit Fabric	EQF6 (bachelor)	Certificate	Technological University of the Shannon (TUS)	Ireland

Construction Project Management	[1] Management & Consultancy	Construction Management, Construction Project Management, ManagersProject Management Institute (PMI), Supervisors	EQF4/5 (post secondary/ tertiary VET)	Certificate	Technological University of the Shannon (TUS)	Ireland
Twin Green and Digital Innovation by SMEs in the Construction Sector	OTHER	NA	EQF7 (master)	Certificate	Haarlem University of Applied Sciences	Netherlands
Opleiding Energietransitie	OTHER	NA	EQF7 (master)	Degree	InHolland	Netherlands
Master of Applied IT	[2] Data processing & Analysis	NA	EQF7 (master)	Degree	Fontys ICT	Netherlands
Digital Social Entrepreneurs for the future of Europe	OTHER	NA	NOT CLEAR	Certificate	DISYOU EU project	INTERNATIONAL
Philosophy of science, technology and society	Multiple	NA	EQF7 (master)	Degree	University of Twente	Netherlands
European Studies on Society, science and technology	Multiple	NA	EQF7 (master)	Degree	Maastricht University	INTERNATIONAL
Technology and Operations Management	[3] Development & Operations	1. Master internship; 2. Energy transition and climate change focus area	EQF7 (master)	Degree	university of Groningen	Netherlands
Science and Innovation	OTHER		EQF7 (master)	Degree	university of Utrecht	Netherlands
Environmental Science for Sustainability, Ecosystems and Technology	Multiple	NA	EQF6 (bachelor)	Degree	Avans Hogeschool	Netherlands
Business It & Management	[1] Management & Consultancy	NA	EQF6 (bachelor)	Degree	Avans Hogeschool	Netherlands
Informatica	OTHER	NA	EQF6 (bachelor)	Degree	Avans Hogeschool	Netherlands
Information Sciences	OTHER	NA	EQF7 (master)	Degree	Vrije Universiteit Amsterdam	Netherlands

Engineering Systems	Multiple	1. Automotive Systems track; 2. Cyber-Physical systems track; 3. Sustainable energy track	EQF7 (master)	Degree	HAN university of applied sciences	Netherlands
Sustainable innovation	OTHER	NA	EQF7 (master)	Degree	Technische Universiteit Eindhoven	Netherlands
Technische Bestuurskunde	OTHER	1. Energie & Industrie; 2. Informatie & Communicatie; 3. Transport & Logistiek	EQF7 (master)	Degree	TUDelft	Netherlands
Management, Society and technology	Multiple	NA	EQF6 (bachelor)	Degree	Universiteit Twente	Netherlands
Geoinformatics	[2] Data processing & Analysis	na	EQF7 (master)	Degree	Eötvös Loránd University, Institute of Cartography and Geoinformatics	Hungary
Business Informatics	[2] Data processing & Analysis	Corporate IT	EQF6 (bachelor)	Degree	Milton Friedman University	Hungary
Business Informatics	[2] Data processing & Analysis	Business management systems, script languages, accounting analysis, Sustainable Enterprise Applications, Operations Research and Decision Theory, Critical Systems Quality Assurance and Audit	EQF6 (bachelor)	Degree	University of Dunaújváros	Hungary
Business Informatics	[2] Data processing & Analysis	na	EQF6 (bachelor)	Degree	University of Debrecen Faculty of Informatics	Hungary
Business Informatics	[2] Data processing & Analysis	na	EQF6 (bachelor)	Degree	University of Szeged Faculty of Science and Informatics	Hungary
Sustainability Reporting and Data Analysis Specialist	[2] Data processing & Analysis	na	NOT CLEAR	Certificate	University of Pécs – Faculty of Business and Economics	Hungary
Precision Management Engineer / Specialist	[1] Management & Consultancy	na	NOT CLEAR	Certificate	Alba Regia Technical Faculty, Óbuda University	Hungary

Geoinformatics	[2] Data processing & Analysis	na	EQF7 (master)	Degree	Alba Regia Technical Faculty, Óbuda University	Hungary
Geoinformatics engineer / specialist	[2] Data processing & Analysis	na	NOT CLEAR	Certificate	Alba Regia Technical Faculty, Óbuda University	Hungary
Digitalisation of agriculture and business	[3] Development & Operations	na	EQF6 (bachelor)	Degree	University of Szeged, Faculty of Agriculture	Hungary
Computer Science and Information Technology	[3] Development & Operations	Computer Science	EQF6 (bachelor)	Degree	National University of Science and Technology Politehnica Bucharest	Romania
Information Engineering (INF).	[3] Development & Operations	IT&C	EQF6 (bachelor)	Degree	National University of Science and Technology Politehnica Bucharest	Romania
Industrial Informatics	[3] Development & Operations	Applied Engineering Sciences	EQF6 (bachelor)	Degree	National University of Science and Technology Politehnica Bucharest	Romania
Computers and information technology	[3] Development & Operations	Information Engineering	EQF6 (bachelor)	Degree	National University of Science and Technology Politehnica Bucharest	Romania
Computers and information technology	[3] Development & Operations	Internet of Things Engineering	EQF6 (bachelor)	Degree	National University of Science and Technology Politehnica Bucharest	Romania
Computer Science and Information Technology	[3] Development & Operations	Parallel and Distributed Systems	EQF7 (master)	Degree	National University of Science and Technology Politehnica Bucharest	Romania

Computer Science and Information Technology	[3] Development & Operations	Advanced Software Services	EQF7 (master)	Degree	National University of Science and Technology Politehnica Bucharest	Romania
Computer Science and Information Technology	[2] Data processing & Analysis	Advanced Analytics for Business	EQF7 (master)	Degree	National University of Science and Technology Politehnica Bucharest	Romania
Enviromental Sustainability and Climate Change Mitigation	[3] Development & Operations	Computing; Electrical Engineering and Information Technology; Control Systems and Robotics; Data Science; Electrical Power Engineering	EQF7 (master)	Degree	Faculty of electrical engineering and computing	Croatia
Implementation of ESG	[1] Management & Consultancy	ESG regulatives, sustainable accounting, green investment	NOT CLEAR	Certificate	Kognosko d.o.o.	Croatia
AD weeks	Multiple	Digital skills for employment, entrepreneurship, and innovation; Digital skills in "Equality, Diversity, and Inclusion" (covering issues such as migration, democratization, gender gap, ethnicity); Digital skills for environment and sustainability; Digital skills for specific sectors (education, cultural and creative industries, transport, healthcare…).	NOT CLEAR		Centar za tehničku kulturu Rijeka	Croatia
Digital transformation	Multiple	specialistic study of computing	EQF8 (post-master, doctorate)	Diploma	Faculty of electrical engineering and computing	Croatia
Master's degree in Sustainability Science and Technology	Multiple	interdisciplinary training to understand the interactions between society, the economy and the environment.	EQF7 (master)	Degree	HE - Universitat Politècnica de Catalunya	Spain
IT and sustainable urban development course	Multiple	how ICTs help the development of sustainable and resilient urban infrastructures	NOT CLEAR	Certificate	HE - Universidad de Jaén	Spain
Online University Master's Degree in Sustainable Tourism and ICTs	Multiple	new ways of understanding, managing and promoting sustainable tourism activities, using ICTs	EQF7 (master)	Degree	HE - Universitat Oberta de Catalunya	Spain

Environment and Information and Communication Technologies (ICTs) in sustainable cities and territories	Multiple	ICT, GIS, maps, ecosystem service	NOT CLEAR	Certificate	HE - Universidad Complutense de Madrid	Spain
Course on ICT tools for sustainability for entrepreneurs	Multiple	Technology solutions that support your business's orientation towards the digital economy and you can discover what technology can do for sustainability.	NOT CLEAR		SOSTENTIC	Spain
Green Tics in Information Technology and Environmental Sustainability Environments Course	Multiple	Teach for Professors of Vocational Training with teaching attribution to teach the Green Tics specialty courses in environments of information technologies and environmental sustainability of the professional families Commerce and Marketing, Computer Science and Communications, Security and Environment.	NOT CLEAR	Certificate	Escuela de Organización Industrial	Spain
Artificial Intelligence and Sustainable Territories Specialization Course	Multiple	To deepen the knowledge of Artificial Intelligence and its potential application to projects, products and services that contribute to environmental improvement and the management of territories that allow the achievement of the global agenda. The program combines technical contents with transversal skills for the direction and management of projects related to artificial intelligence and its application in different fields.	NOT CLEAR	Certificate	Universitat de València and ValgrAI	Spain
Digitalization and sustainability: the impact of ICT on the environment	Multiple	This program can be taken for free and teaches the impact that electronic devices have on the environment throughout the life cycle of a product, from the extraction of raw materials, through their manufacturing, use and final disposal. It also teaches good practices for sustainable consumption of ICT and the skills that both citizens and teachers must have to transmit these good practices.	EQF4/5 (post secondary/ tertiary VET)	Certificate	Universidad Rey Juan Carlos	Spain

Master on Geomatics, Remote Sensing and Spatial Models Applied to Forest Management	Multiple	Its main objective is to promote early-carrier engineers, biologists, geographers and environmentalists in research and professional task related to GIS, remote sensing and spatial models for assessing forest ecosystems. Students will be able to carry out projects related to silviculture, forest management, forest restoration, monitoring of abiotic and biotic perturbations, adaptation and mitigation of forests to global change and land planning.These skills allow MSc student to solve real problems related to management and assessment of forest ecosystems, by using new techniques such as GIS, remote sensing and forest modelling.	EQF7 (master)	Degree	University of Córdoba	Spain
University Master's degree in distributed renewable energy	Multiple	The objective of the Master is to acquire solid knowledge in the different renewable energies, as well as the necessary skills and abilities that facilitate the research and implementation of Information and Communications Technologies (ICT) in the field of Distributed Renewable Energies. The different collaboration agreements signed with leading institutions and companies in the sector will allow the practical training to be completed.	EQF7 (master)	Degree	University of Córdoba in association with: Universidad de Cádiz, HTW Berlin and the Instituto Nacional de Técnica Aeroespacial (INTA).	Spain
Erasmus Mundus Master's Degree in Sustainable Transport and Electrical Power Systems from the University of Oviedo; Polytechnic Institute of Coimbra	Multiple	The main objective of this Master is the training of qualified personnel in areas related to electrical energy management, with emphasis on power systems for renewable energies, in order to provide solutions to create sustainable transportation options.	EQF7 (master)	Degree	University of Oviedo in association with: The University of Nottingham Sapienza University of Rome Polytechnic Institute of Coimbra	Spain
Master's Degree in Artificial Intelligence applied to the Energy and Infrastructure sector	Multiple	In this Master's degree, students will be able to build technological solutions applied to the energy and infrastructure sector, using reasoning and automatic planning techniques. They will be able to use search algorithms, multi-agent systems, machine learning, and deep machine learning to achieve an optimal response. And evaluate the performance and impact of these responses according to technological, economic and social criteria.	EQF7 (master)	Degree	Universidad Internacional de la Rioja in association with: University of Alcalá and University of Universidad Rey Juan Carlos	Spain

Master's Degree in Tools and Technologies for the Design of Intelligent Architectural Spaces	Multiple	Design spaces that integrate sensorization and automation technologies, Coordinate the manufacturing and assembly of unique architectural elements, Develop Virtual Reality projects in the field of architecture, Produce prototypes and architectural models using digital manufacturing techniques. And they will do all this through courses, some focused on digital tools and others on sustainability.	EQF7 (master)	Degree	Universidad Internacional de la Rioja	Spain
Applied Environmental Studies "Angewandte Umweltwissenschaften""	Multiple	Interdescplinary Training and Education to examine and improve the skills in the fields of environmental sciences, environmental law and planning, environmental and sustainability management and environmental technology.	EQF7 (master)	Degree	Universität Koblenz - UNIKO - University of Koblenz	Germany
Sustainability and Transformation Management	[1] Management & Consultancy	The focus is on how busnisses can have professionals who are able align their practices with the emerging global climate targets and the UN Sustainable Development Goals	EQF7 (master)	Degree	Hochschule Fresenius (University of Applied Sciences)	Germany
International Business—Sustainability Management	[1] Management & Consultancy	The program aims to tackle the complex relationships between economy, ecology, and society and unite them in future-oriented strategies for modern companies.	EQF7 (master)	Degree	Berlin University of Appied Sciences	Germany
Goethe MBA	[1] Management & Consultancy	This MBA program aims to have a customizable focus on digital transformation, data science, and sustainability.	EQF7 (master)	Degree	Goethe business School - Frankfurt University	Germany
M.Sc. Sustainability Management: Technology, Analytics & Transformation	Multiple	The M.Sc. Sustainability Management transforms highly sought-after sustainability enablers who have all the necessary expertise & management know-how to guide a company on its path to sustainable and responsible operations.	EQF7 (master)	Degree	Die RWTH (Rheinisch-Westfälische Technische Hochschule) Aachen - RWTH Aachen University	Germany
Master in Sustainable Management & Technology	Multiple	The master's program in Sustainable Management and Technology promises to bring in a link between business and technical areas of enterprise.	EQF7 (master)	Degree	TUM School of Management Technical University of Munich	Germany
Mannheim Master in Sustainability & Impact Management	[1] Management & Consultancy	This master's program promises a catered education designed for working professionals.Its main focus is on sustainability.	EQF7 (master)	Degree	Mannheim Business School	Germany

Sustainability Management MBA	[1] Management & Consultancy	This master program teaches the latest knowledge and trends in sustainability that can be beneficial to professionals working in corporate environments.	EQF7 (master)	Degree	Fernhochschule - The Mobile University	Germany
Sustainable Development	Multiple	The international, interdisciplinary and research-oriented degree program deals with issues of sustainability, environment and development and with the challenges in the transition to a sustainable society.	EQF7 (master)	Degree	University of Leipzig	Germany
Master's Course in Sustainable Business	[1] Management & Consultancy	The Master program concentrates on four main pillars: Corporate Finance, International Marketing, Sustainable Business, and Innovation & Digital Business.	EQF7 (master)	Degree	Munich Business School - University of Applied Sciences	Germany
Sustainable Transition	[1] Management & Consultancy	The Master's degree programme Sustainable Transition is the first fully online degree programme at Justus Liebig University Giessen, offered by the Faculty of Agricultural Sciences, Nutritional Sciences and Environmental Management (Faculty 09), a faculty with recognised expertise in the scientific analysis of agricultural and food systems	EQF7 (master)	Degree	Justus-Liebig-University of Giessen	Germany

D2.1.Annex.G Analysis of national expert panels

7.1 Approach

Expert panels are a widely used method to gain insight into future situations. With this method, experts synchronously discuss possible future scenarios on a specific topic during meetings. The aim is to reach a consensus, but it is also possible that the outcome consists of two or more scenarios. In each country of the consortium, national panels of experts were organised by the partner(s) in that country.

In addition to the national expert panels, a European expert panel was also held to validate and generalise the results of the national expert panels and the other data collected and analysed.

The invited experts were experts on digital for sustainability in general or on labour market and/or education trends. These were for example questionnaire respondents that have a good insight into future developments, but also other experts from the marketplace, governmental institutions, NGOs, or academia.

Per country, partners were asked to organise at least one expert panel meeting with 8 to 15 participants.

The expert panel meetings followed the format of a relatively open questioning of experts, where experts were given the opportunity to express their expectations regarding future demand and engage in discussion about it. The panel moderator(s) steered the discussion in the right direction by asking open-ended questions related to future digital sustainability roles, skills and education/training needs. To achieve consistency among the expert panels, a protocol was used for moderating an expert panel meeting, including preliminary guiding questions. The meetings were held in the local language. A format was used for reporting the results of the national expert panel meetings, with a description of the discussion, key findings and relevant quotes. The reporting format was accompanied by a guideline to ensure as much consistency between the panel reports as possible. The reports were written in English.

The analysis of the expert panels provides an overview of the opinions of experts on the future demand of digital for sustainability roles, competences, skills and knowledge.

7.2 Results

There are national experts panels held in every country in which the consortium has at least one partner. This resulted in 90 experts participating in 12 national expert panels. Although the methodology prescribes that it should be panel meetings in some cases this was (partly) replaced with individual interviews. This leads to slightly different results because of the different dynamics between researcher and respondent, but given the choice between no input from an expert or a slightly different way of data collection, the choice was made to get their input using individual interviews.

A portion of the experts are active in a specialised digital sustainability vendor, service provider, or consultancy. A larger group works at a general ICT organisation, which does not mean that they themselves are not specialising in digital for sustainability. Others are active in a private organisation in another sector or at a public organisation of which most are in education. In total 27% of the respondents work in education, which also explains why 21% of the experts are researchers. The other roles experts have within their organisation are varying from CEO or owner (29%) to more specific digital sustainability roles (36%) like ESG director, project manager sustainable IT, and sustainability expert. The owners are mostly owners of micro organisations which make up 20% of the organisations in which the experts are active in. Overall 38% of the experts are part of a large organisation, so 62% in SMEs. The sectors the organisations are active in, besides education, are mainly ICT (19%) or in the sector "other service activities" (38%) which consist of digital sustainability service providers, amongst other services.

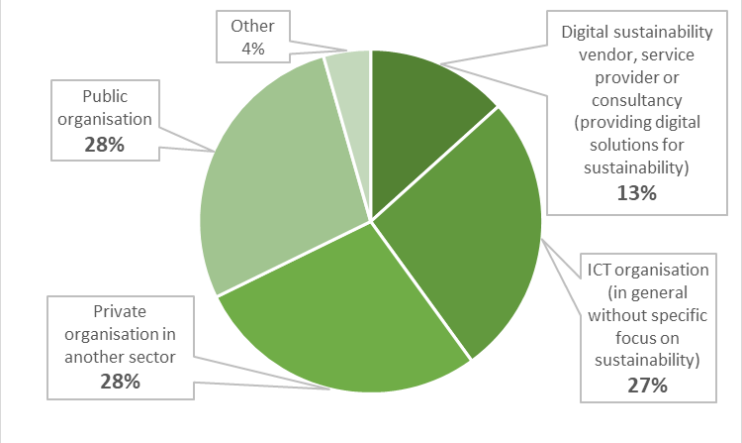


Figure 61 Kinds of organisations experts are active in

The EU expert panel consists of 15 experts from 12 countries. It is a mix of professors, CEOs, and other professionals that all are active in the combination of the fields of digital and sustainability.

7.3 Main findings

The Main findings of the national expert panels are organised in line with the three main topics defined in the methodology, namely the digital for sustainability roles, skills, and education & training. All these three topics are discussed with regards to the current needs and the future needs.

7.3.1 Roles needed now

Figure 62 Word cloud of roles needed now

Currently, **ESG reporting** is dictating the digital sustainability landscape. Organisations are figuring out how to comply to the CSR Directive in the most efficient way. Because there is uncertainty about how the concept of digital sustainability will evolve and because the topic is considered unclear, complex and abstract, with directly measurable results difficult to see, organisations face major challenges in making it clear and actionable. This is also well reflected in the demand for digital sustainability roles in the short term. Particularly, **SME's** are struggling to find resources in this area. They cannot hire a full time (digital) sustainability expert, so they opt for **reskilling current staff or hire a consultant** to guide the way in the regulatory landscape. For **larger organisations**, **data related roles** are important in relation to **collecting and organising data and impact measurement** in the light of the ESG reporting.

"The demand for in-house experts will mainly arrive from big companies."

"Small and medium-sized companies will need external consultants to guide them on certain aspects."

Opinions differ among the panels about who exactly needs to possess sustainability skills, ranging from **top management**, to **line management**, via **certain people from IT staff** to **all of the IT staff**. Expert panels also differ on the point to **the extent to which IT specialists**, like the data analysts and the software developers **must be skilled** in this topic versus their managers. Several panels state a **sustainability software developer or engineer** is absolutely needed and also digital sustainability roles related to **solution design and process optimisation**. In a couple of panels, the **centrality** of the digital sustainability role is stressed, with **boundary-spanning, inter- and multidisciplinary characteristics**, mastering multiple disciplines, a **Pi- or M-shaped professional**, together with the importance of **a transversal and behavioural skillset**.

"This is not a mandatory new role or position but a transversal job that needs to be done."

In some panels the wish and need **to broaden the current scope of sustainability** is expressed, beyond ESG reporting obligations and minimising the carbon footprint. Taking into account **broader climate aspect**s is relevant in the case of **smart cities** and **social and ethical aspects** are mentioned in relation to AI but also to IT in a general sense.

In general, roles for which the demand is expected to rise are the ones **focused on ESG reporting**, like **environmental/ sustainability/ESG reporting managers** and the associated **data-related roles**, such as **data architects, data engineers, data managers and data analysts**, besides roles in **ESG consultancy**. There is also a need for a person who can develop a digital sustainability strategy, so **a digital sustainability leader**. Besides these roles, other roles mentioned are **a (digital) sustainability champion**, someone responsible for the communication regarding the concept of sustainability, **a sustainability change management role** to support the transition, **a digital sustainability tester** and **a digital sustainability teacher**. There is also demand expected for **jobs in the area of smart cities**, covering topics like water management, IoT, material flow management and data security.

7.3.2 Roles needed in the future

Figure 63 Word cloud of roles needed in the future

In the long run, experts predict an integration of sustainability into all organisational functions and almost all expert panels expect an increase in demand for digital sustainability roles, although some are uncertain about the demand for specific roles. It is even expected that sustainability has become 'business as usual'. The roles that are mentioned are mainly based on current trends and a few mention new roles that do not yet exist.

"The convergence of digital and sustainability will not just lead to the creation of new roles but will also redefine existing positions."

Experts expect a rise in demand for **digital sustainability consultants**, especially in relation to SMEs and for **(business) sustainability analysts,** especially related to sustainable service providers and larger companies, due to legal obligations, focusing on analysing the relative benefits of sustainable solutions. An increase is also foreseen in the demand for technical roles like ICT **sustainable software developers/administrators/architects, systems administrators, intelligent energy systems architects,** and **roles related to smart cities**. A need is also reported for **digital sustainability leaders** and **digital sustainability managers**. In general, digital sustainability roles are expected to be **multidisciplinary**, combining expertise from different fields.

It is also expected that there will be **a central key managerial role,** possibly a **new C-Level role**, **a Chief of Execution (CoE),** a person without deep expertise but who can connect the dots and who oversees transformation and cross-departmental or even cross-organisational alignment

changes. Roles are expected to be **multidisciplinary,** combining expertise in environmental sciences and sustainability with knowledge and skills in other fields, for example, HR, accounting, legal and or management skills.

"I think the level of knowledge required for these roles is so diverse, and you need to have somebody in the organisation who can see through the different elements of sustainability, it requires complex knowledge."

In addition, **someone with deep knowledge of environmental and social impact factors** will be needed, taking into account geopolitical aspects. Only this awareness of the analogue infrastructure behind the digital level will lead to a change of focus and of **business models to take account of the analogue**: resilience, proximity, circular economy; thus, realising a truly sustainable digital transformation.

7.3.3 Skills needed now

Figure 64 Word cloud of skills needed now

Regarding the digital sustainability skills needed in the short term, experts note that these depend on the stage of the digital sustainability transformation a country or organisation is currently in. The experts outline two scenarios, a country-level scenario from awareness to skills development through education and training and an organisation-level scenario from developing a strategy to implementing it.

In most panels, the discussion is about sustainable systems rather than systems that support sustainability. This is attributed to a **lack of understanding of the term sustainability**, that is often

equated with only environmental protection, leaving out big social themes, big resilience themes and big economic themes. This goes hand in hand with a **lack of understanding of the impact** of digital technology, with the negative impact little or not understood and the positive impact almost never exploited. This means that a relatively large proportion of the skills mentioned by experts are related to the development of energy-efficient systems and focus on carbon-neutrality.

"We forget about the other aspect of sustainability - the social aspect. All the companies that want to compete in the market will need someone who has a holistic view of sustainability, not just one in a specific area."

ESG reporting skills and an **understanding of (environmental) legislation** are considered very important. These are skills discussed by the majority of panels. Panels differ on who should possess this legislative expertise and to what extent. Having a **multidisciplinary and/or interdisciplinary skillset** is also considered important for all digital sustainability professionals. This skillset is a mix of **management skills** with **skills in different categories (technical, strategic and intercultural)** and **fields** (sustainability, legislation, and fields like e.g., marketing, communication, innovation). Technical skills focus on **energy-efficient technologies**, but also listed are **IoT, programming languages, cloud platforms, Edge/Fog Computing, and AR/VR development**. **Data skills** are also often mentioned as important.

When it comes to more sustainability skills and competences, experts mention **understanding sustainability frameworks and being familiar with sustainable practices**; like life-cycle analysis and circular economy models, the importance of the value chain, circular systems and electronic waste management; having an **understanding of sustainability impacts** and the principles behind that, such as **cause-and-effect relationships** and the capacity to **measure and valorise impacts,** also related to the broader environmental, social and economic impacts. This should be combined with a **holistic and interdisciplinary design approach** in order to translate those principles into digital solutions.

"No one knows which direction everything will go, but we need to be aware that we must strategically invest in changing the mindset of employees, management, and ultimately the entire company."

Management skills and **soft skills** in general, and particularly communication and **collaboration** are listed in several panel reports. Other skills/ competences mentioned are **innovation skills, problem-solving skills, critical thinking, strategic thinking, adaptability, learning ability, intercultural skills, organisational awareness, situational awareness** and **understanding of interdependencies**.

Personal attributes that are highlighted are: **empathy, engagement, personal commitment, taking responsibility, sensitivity** and **credibility**. Some striking skills mentioned are **anticipatory skills, ability to think horizontally** and the **ability to unlearn**.

7.3.4 Skills needed in the future

Figure 65 Word cloud of skills needed in the future

Overall, the experts outline an **extrapolation of current trends and skills** for the long term. They expect an increase in demand for digital skills in sustainability, fuelled by legislation and an increasing awareness among society and consumers. Sustainability in general **will be more integrated** in organisational strategies and activities and companies are expected to be actively working on implementation. It is not only about management of sustainability projects, but **organisational processes will change** and adhere more and more to sustainability principles, such as sustainable IT project management, sustainable change management and sustainable procurement management.

These trends, and in particular also the mandatory ESG reporting, are increasing the importance of **impact measurement** of measures taken and thus **data collection and analysis, with AI and ML** in the background. Experts see a further professionalisation in the field of impact measurement and evaluation.

Just like the short-term, **the focus is largely on climate and energy-efficiency**, so **rather on sustainable IT instead of IT for sustainability**. In some panels, though, other expected trends mentioned relate to broadening the scope of the current mainstream sustainability practices and discourse. Organisations are expected to look more and more across their organisation boundaries and **take the entire supply chain and their procurement processes** into account, which will be reviewed in the light of (digital) sustainability principles. There is also already **a movement from carbon measurement to a more global measurement with changing impact factors**, along with the development of digital solutions that have **a net positive impact** on sustainability, in line with the principles of the **regenerative economy**. **Social sustainability** is explicitly mentioned, as well as the importance of developing a corporate culture that supports **humanity**.

"Most of the environmental and social impacts are in the supply chain and manufacturing. I think it is necessary in the coming years to develop skills on sustainable digital purchasing."

An increasing focus on implementation is reflected in the long term expected need for interpersonal soft/transversal skills such as **communication**, especially **storytelling, collaboration, management, change management** and **leadership**; particularly **value-oriented leadership** skills with **social engagement** as departments and teams need to work together and employees need to be convinced. A sustainability champion is a suggested role in this respect.

"At the leadership level, personal commitment is very important, and credibility. If you are not committed to sustainability, you will not be credible, and you will not be able to carry these efforts through the company properly."

The most important skill on a personal level is clearly **adaptability**, mentioned by many expert panels. Other personal skills relate to **empathy, continuous learning, creativity, curiosity, high**

tolerance, critical thinking, visionary thinking, strategic foresight and **having a systemic vision** of the organisation.

On organisational level needed skills relate to the **management of sustainability projects**, but also to **sustainable IT project management,** and **sustainable change management**. Besides this, **an understanding of the market**, **incentives**, and **consumer behaviour** together with **risk analysis** and management are not only essential to **prepare for changes,** but also valuable for **evaluating the impact of digital sustainability solutions**. All this goes hand in hand with **(strategic) innovation**. Also, knowledge of **the regulatory framework and all related updates** are mentioned, partly related to **sustainability/ESG reporting**.

The most needed skills in the area of sustainability relate to **principles of the circular economy**. Other digital sustainability skills listed by the experts are **life-cycle assessment, green IT practices, the ability to design for sustainability from the ground up, advanced energy-efficient technologies**, **integrate sustainability into software development life cycles** and **develop methodologies to continuously improve the environmental performance of digital solutions**.

Both **impact measurement** and **processing data** are mentioned in half of the panel reports. It is considered crucial to the long-term success of digital sustainability initiatives that professionals are able to **use data and metrics to measure the impact of their actions and make informed decisions**. Additionally, skills in **AI and ML** are needed for **improving predictive analytics,** and **enabling automated decision-making** in sustainability efforts.

"A sustainability officer needs to have a background in environmental information, as well as technical know-how about data management."

There is a slight difference between some panels in relating skills to certain roles. In two panels the experts relate a deep understanding of emerging sustainability trends and the changing regulatory landscape only to executive positions such as digital sustainability leaders and managers, while in another panel the experts see regulatory understanding rather as a more transversal skill, applicable to a range of roles.

For a digital sustainability transformation to be successful in the long term, experts advise that organisations need to take a holistic approach, adapt their business models, create a supportive

culture, collaborate across departments, be aware of EU funding in this area and find a common ground between business staff and environmental scientists.

7.3.5 Education & training needs now

Many panels start the discussion with **a call for action on the side of formal education**. They should reform their curricula; with **full integration** of sustainability in traditional courses across all subjects, create **interdisciplinary curricula** merging technology, environmental science and business strategy, **introduce separate courses/modules** or **transform existing modules** and **integrate real-world applications and case studies** into educational programmes to provide a full understanding of how digital tools can be applied to sustainability challenges.

Alongside this call for action on formal education, experts on many panels stress the **urgent need to reskill** and **upskill the existing workforce.** Experts suggest that this should take the form of **short training courses** with **certifications** or **micro-credentials.**

"Results cannot be achieved in a short period, but that does not mean we should stop or not begin something new and innovative. It is necessary to raise awareness among people about what they are doing and how it contributes to sustainability and sustainable business, and how digital skills can help with this."

In many panels, experts distinguish between **different types of training**. Mentioned are: **(short) awareness-raising training, basic training on fundamentals** and **more advanced training for experienced professionals**. Some panels express the need for **basic sustainability and climate change training for all employees** to build a culture of sustainability within organisations. Awareness-raising training should be followed up on the practical implications in the workplace.

There is a need for **tailored training** in digital sustainability **for specific, already existing roles** to equip professionals with the skills they need to incorporate sustainability into their daily responsibilities. Mentioned are training for **leaders**, **managers** and **HR executives**, to get these people involved in the topic and explain what it means specifically for them. Also mentioned are training for **data engineers** and **other IT professionals** and **specialised technical profiles** to explain best practices in digital sustainability.

"Training data specialists is an important step, but there must also be a real focus on strategic change. Data analysts are usually not in a position to put sustainability on the agenda. So if there is no demand from companies, it makes little sense to train people."

Additionally, training should have a **multidisciplinary approach** to bridge different disciplines and could be delivered by a **dedicated in-house trainer** or through **shared roles between departments. Support from senior management** is seen as a prerequisite for success.

Key skills that should be included in training programmes are **understanding environmental regulations**, **sustainability reporting**, **data analytics**, **systems thinking**, **sustainable design principles** and the **use of advanced technologies** such as **AI**, **IoT**, **AR/VR**. Courses and certification preparation in **IoT, Cloud Computing, Edge/Fog Computing** and **AR/VR** are essential for *software developers and engineers.* Provision of training is especially important in the fields of **data analysis, sustainability consulting** and **operations management.**

Many panels indicate **a need for some form of cooperation between education, industry and government. The business sector could provide valuable insights** into the skills and knowledge that are most in demand so that the education offer matches the needs of the labour market. **Government support** is considered crucial to **encourage companies and educational institutions to invest** in sustainability education and training initiatives.

In the coming years, **more clarity is needed on what sustainability means** and how it can be implemented. Meanwhile, it is crucial to **foster a mindset in which ethical considerations play a role when deploying technology.**

"Sustainability terms must be clarified as they are not clear for IT people, as well as IT concepts are not clear for pure sustainability roles."

7.3.6 Education & training needs in the future

In the long term, many experts expect there will be **a demand for tailored training for various functions in specialised areas,** such as **human resources, procurement, C-level executives, management and technical functions.**

"This is a combination of business leaders, technologists and administrators needing new skills – consider persona-based training."

Experts mention a range of business, technical and sustainability topics for these specialised training courses, such as sustainability consulting, sustainable IT procurement, sustainable supply chain management, sustainable cloud computing strategies and sustainable finance in the area of business; sustainable infrastructure design, sustainable application development, data management and analytics and cloud performance optimisation for technical functions; and fundamentals of ecology, EU policies and regulations, understanding sustainability data, energy efficiency and waste management in the field of sustainability.

Besides specialised training, there is a need for a **general sustainability training for all employees.**

Continuous learning and professional development (CPD) are considered highly important. It is even argued that this should be mandatory for all professionals, regardless of sector, to keep their skills up-to-date and relevant.

Regarding formal education, experts expect a strong call for formal education pathways and comprehensive degree programmes in digital sustainability, with development of **dedicated BSc and MSc programmes and dual masters**, that combine sustainability with any other expertise. Additionally. In addition, it is also argued that the **basics for (digital) sustainability skills and principles should be present in any education and professional training at all levels,** including secondary education. This is considered a prerequisite for students from all disciplines to develop a sustainability mindset and consider the environmental, social, and economic impacts of their future professional activities. **Practical experience** during education and training is also considered very important, e.g. through internships, apprenticeships, mentoring and situational learning.

"As the trainings must be oriented towards the needs of the entities that will actually open positions for people with those competencies, those needs must be well understood (at least on some level) and a contact between the educational institutions and these entities must be facilitated."

Experts also point to the **importance of effective collaboration between industry and education and training institutes** which will ensure that curricula are aligned with the evolving needs of the labour market.

In the end it is stated that it all comes down to the essential question: Are people willing to change their behaviour? This determines whether we will end up with a sustainability debt or with truly sustainable practices that elevate our collective well-being.

"The world is changing with or without us. We can only choose if we want to be a part of the change or not."

7.3.7 European expert panel

At the European level, the debate evolved around a series of statements containing some of the key findings of the national expert panels. These statements served to stimulate discussion, with as much free space as possible for the experts to express their personal opinions, including comments using virtual post-its.

7.3.7.1 ESG role

Overall, the experts agree that **ESG** is just one small area and is **not the main focus** in many organisations, and also should not be the main focus. In a small organisation, the scope may be narrower, and tasks related to reporting and ESG may be assigned to one person and the CEO must be involved, while in larger organisations there could be a dedicated administrative specialist, knowledgeable in legislation and responsible for ESG reporting.

"I don't think ESG is the main job role, it's just one area. We actually just spent the last two days [...] having a sustainability forum, bringing all the different parts together. [...] We had the sustainability office, we had software, we had research, we had supply chain, we had infrastructure, we had global real estate, we had corporate social responsibility, we had ESG, so that's lots of different roles."

However, it is a hard task for one person to be aware of how to be more sustainable in many areas. Many **SMEs** are focused on the operational level and everyday business, so regarding

sustainability they will focus on practical skills, which can bring added value to everyday business, like sustainable procurement and automation together with some reporting obligations.

7.3.7.2 Many roles

Sustainability is about behaviour change, business change and product development change, even a paradigm change, and involves **integration into the full governance structure** of an organisation.

"Sustainability in depth is a lot more than calculating emissions. It's also behavioural change, economy of the core activities inside the company, economy of the products [...]. And this is a role that is more into business development and product development, rather than an ESG role."

When starting a sustainability project, particularly in a large organisation, **many different roles and departments are involved** across the whole organisation, e.g. sustainability office, CSR, research, lifecycle assessment specialists, product designers, software developers, infrastructure, supply chain, real estate, HR, finance, marketing and communication etc. And also, the **impact on all the parts of the whole organisation** must be taken into account.

"Actually we need **sustainability as part of the DNA**. So when you are creating new products or new software, the developers are thinking about it how do you do a responsible computing framework that the HR teams can pick up, the CSR teams can pick up, the developers can pick up, [...] and go: 'Right, I've got a project. How does that affect my data centre? How does it affect my infrastructure? How does it affect the developers, the data governance, the systems and the impact?'"

7.3.7.3 Teams, leadership role or transversal role?

There must be a central key manager or C-level role in a larger organisation. A person that needs to have technical skills, knowledge about ESG and sustainability and some business skills to lead the way and raise awareness. This role does not exist yet. At the same time, sustainability cannot be the responsibility of just one person. Given its complex and broad nature, a systemic view is needed and it should be addressed by teams.

"I'm gonna be a bit sceptical about just putting all the all the burden in just a specific professional. For me it is a very complex problem. So maybe I would prefer to talk about, instead of specific professionals, talk about teams."

Currently, organisations invest in **a transversal role** which works together with different departments, having a sustainability background, but also involving IT.

There is a need for such a role that can communicate with both the technical people and the people responsible for sustainability and ESG etc. A solid starting point could be s**kills related to 'electricity'.** Having these will help demystifying 'magical' sustainability solutions and drive correct conclusions. On the other hand, energy consumption is just one indicator when addressing sustainability.

7.3.7.4 Data

The **most difficult role to fill is the one that relates to data and sustainability.** It is crucial that **data is available and can be trusted.** Especially in larger, dispersed companies, it is essential that at all locations, the same data dictionaries, assets and terminologies are used. In general, **one needs to think about how IT and emerging technologies** (blockchain, IoT, robotics etc.) **could help** to automate, simplify and enable informed decision making. **Data is needed to reach sustainability goals**, and this should be an aspect when educating for sustainability.

7.3.7.5 Legislation vs scope

In general, **companies are very pragmatic** and need incentives to act, like **labels or legislation.** At the same time, legislation and standards **can impact innovation, both in a negative and in a positive way,** as organisations need to find ways to comply. Probably, **SME's will need to cooperate,** if they want to invest and implement innovative solutions**.**

Experts agree that although these incentives are needed, sustainability involves a change in mindset, so compliance with regulations should not become the aim. Sustainability cannot be reached simply through business as usual and considering sustainability as an add-on. The **current focus on output, environmental sustainability, energy consumption and negative impact is far too limited**.

"Basically we need a systemic change here and I personally do not think we'll manage to reach that with business as usual. And I'm really wondering why I see so little the idea of having specialists in sustainability, and as long as you don't have this basic knowledge and you're here with your IT knowledge and really IT problems, you'll just consider sustainability being an add-on."

The broader scope of the concept of sustainability must be taken into account, addressing its positive impact and the broader set of stakeholders; creating value in the three dimensions: society, economy and the environment. The skills needed for this also depend on the **maturity level of the organisation** in relation to managing sustainability in these three dimensions. An option would be **to skill people who are already knowledgeable in the complex field of sustainability, instead of the other way around.**

7.3.7.6 Frameworks

At the European level there are **frameworks and also standardised methodologies**. For example, federations make life cycle assessment models available for their members, including SME's. To many organisations, these resources are a **black box.** There is also very **little information on how to implement** these frameworks, for example how can the GreenComp framework be translated into curricula or applied in a company? It must also be clear if the focus is on digital skills for sustainability jobs or on green skills for IT jobs.

"The green competence framework that is the European sustainability competence framework, is not easy to read, is not easy to prepare a curriculum even for VET. [...] So we have to make this framework easily to be adopted by teachers or by trainers, by SMEs. There is a gap there."

Being able to connect the dots is important in this respect. For example, how do the different sustainability legislations relate to each other and how can different sustainability tools be connected and aligned with the specific needs of a particular organisation?

"So, I think, from a sustainability point of view [...] people need to think about how IT and emerging technologies can help automate, simplify and allow them to make more informed

decisions to get energy levels down quicker [...] or any social sides, they need the data and I think that's what's important that we need to get across in any education."

7.3.7.7 The new normal after the twin transition?

The situation after a successful twin transition will involve **bio economy** and the **creation of local and regional supply chains.** Currently, the tendency is to think dematerialised, so not taking into account the analogue world. **Behind every digital application there is an analogue infrastructure, that should be taken into account** when it comes to sustainability. Both the impact of the digital solution and the impact of the analogue infrastructure must be considered, to analyse whether a solution is globally positive or globally negative. The current discourse does not include these topics. **It is important to address these, especially when educating tomorrow's workforce.**

7.4 Analysis

The in-depth analysis of the national expert panels is also structured according to the three main topics defined in the methodology and then again both for now and the future. The first part are the findings of the analysis comparing and combining the results of the different national expert panels. In the second part of each section, a brief overview of the findings of each of the national expert panels is provided.

7.4.1 Roles needed now

7.4.1.1 Influence of regulation and CSR Directive

Many expert panels start with discussing the consequences of the CSR Directive. Overall, it can be observed that the sustainability focus is dictated by this legislation and lies with ESG reporting and everything related to it. This topic comes up first in almost every expert panel report [BE,HR,EE,FR,IE,IT,NL,SI]. This means that while the concept of digital sustainability gets attention and is on the agenda, it has a limited interpretation and is mainly 'carbon footprint' focused. The need to have to comply with this legislation is clearly recognisable in the roles that are now in demand and which experts expect to increase in the coming years, namely: **roles focused on ESG reporting**, such as the **environmental manager** [FR], the **sustainability manager/officer** [HR,EE,SI], an **ESG-business strategist** [NL], the **ESG reporting manager** [FR], the associated data-

related roles, such as **data architects** [BE], **data engineers** [BE,EE], **data managers** [FR] and **data analysts** [BE,EE,FR,ES,IT], focussing on collecting and organising data and impact measurement; and **consultancy** in this area [BG,EE,ES,FR,IT,RO,SI]. There is also a rising need for **digital sustainability leader** [BE,BG,ES,IT], who can develop a strategy and who understands sustainability.

Overall, in the short term, roles in digital sustainability will primarily focus on **ESG, consultancy, operations, and data analysis**, indicating a shift towards more **data-driven decision-making processes** in sustainability efforts [IT].

7.4.1.2 Practical implementation

With regard to the practical implementation in roles, the expert panels differ considerably.

Some are firmly convinced of the importance and expected demand for certain roles [BE,FR,HU,IT], many others expect that skills application is or can be rather essential [BG,HR,FR,IE,NL] and whether this should be done in some specific roles [IE,HR], in many roles [FR] or in all (IT) staff [BG]. Some note that there will be new roles and that traditional roles will evolve, including sustainability competencies [IT].

Some panel reports hardly, if at all, mention specific roles, but rather discuss specific skills or characteristics [HR,NL]. To whom exactly these skills should be applied, opinions also differ. Is top management the crucial factor, who has to be convinced and set the strategy [BG,HU,IE,ES]? Or is it rather the (sustainability) manager who has to give others assignments [BG,FR] and is responsible for the implementation of the strategy [BG,EE,HU]? Or is it others such as asset managers, public procurement officers, project managers, product managers and digital marketing managers [FR], or is it all IT staff [BG]?

Many argue that there should be someone leading and managing [BE,BG,FR,HU,ES], while others argue that this will not work on the contrary, only telling others what they are supposed to do [FR].

Figure 32 Word cloud of needs for roles in relation to skills

7.4.1.3 Agency

Panels also differ among themselves on **the level of responsibility and autonomy** assigned to roles. For instance, it is stated that a **data analyst** can suffice with an assignment given to him by the manager and does not need to know anything about the subject himself [NL]. In this case, the manager needs digital sustainability training to be able to give the right queries [NL]. Or, on the contrary, should a data analist have expertise in sustainability [EE]? Or should a sustainability data analyst be hired if you also develop sustainability solutions in-house [BE]? In this case, this person should havea high level of knowledge in sustainable IT [BE], focussing on analysing and leveraging data to support sustainability initiatives [EE] and for impact measurement in relation to ESG [BE]. And is the data analyst in fact a key role here, who must know what he is doing in the analysis in order to inform others properly [BG] having an expertise in data analysis and visualisation that are needed to drive informed sustainability decisions and implement initiatives successfully [BG], who is even an **ethical data engineer** for smart, ethical and inclusive data gathering, to mitigate biased information [BE]; or to be able to deliver specialised results in e.g., environmental data in smart cities and IoT? [FR]

Figure 33 Word cloud of Sustainability Data Analyst

Similarly, panels also differ whether a **sustainability software developer/engineer** is needed. It is stated that this is definitely the case [BG,FR,HU,RO], and that this person even plays a key role [HU] as sustainable software practices can optimize code and infrastructure to reduce energy usage that reduces the carbon footprint [HU] and this person must be creative and capable of developing novel solutions [BG], resulting in roles like **digital solution eco-designer** (for architects and developers).

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Figure 34 Word cloud of Sustainability Software Developer

There is also some need reported for roles in sustainable processes and operations [IT], such as **green operations specialists** [IT], **energy efficiency engineer** [FR] and roles related to **process optimisation/automation - footprint reduction** [FR]. Likewise, also the **tester** in development and operations must have sustainability skills [HU]. Others state that software engineers can develop software regardless of the objective and can work across sectors, so there is no need for people working as digital sustainability software engineers [BE].

7.4.1.4 Organisation size and type

An important factor appears to be organisation size and related available resources. It is often mentioned that **SME's in particular lack the budget and people** to establish dedicated digital sustainability functions [HR,ES,HU,IE,RO,SI]. Often **only larger organisations can afford** having people working in dedicated (digital) sustainability functions [HR,FR,IE,RO], while **SMEs** adopt more of a muddling through strategy and **train skills among existing staff** [FR,IE] or **hire a digital sustainability consultant** [FR,RO]. Another factor is organisation type. Experts indicate differences between the **public and private sector**; roles in the public sector tend to be more compliance-focused, while the private sector prioritise roles that drive innovation and operational efficiency [BG]. Also, organisations operating in **more traditional industries** like construction and manufacturing are less involved in digitalisation, let alone concerned with digital sustainability [BG].

7.4.1.5 Centrality

In some panels, a digital sustainability role is characterised as having **a central character**, and correlated terms like **boundary spanning** [NL], **multi- and interdisciplinarity** [ES,IT,NL] and **cross-functional teamwork** [BG] are mentioned. The key is being able to collaborate with people from different departments and mastering multiple disciplines, a **Pi- or M-shaped professional** [NL], combining multiple fields, like digital, sustainability, legal [NL] and sector-specific competences [SI], such as **Digital Sustainability Managers** or **Environmental Data Analysts**, who can **bridge the gap** between technology and environmental stewardship [IT]. **Transversal and behavioural aspects** are also important within this role [BG,HR,ES,NL]. It is further stated that this role combines technical aspects with management aspects [FR,BG].

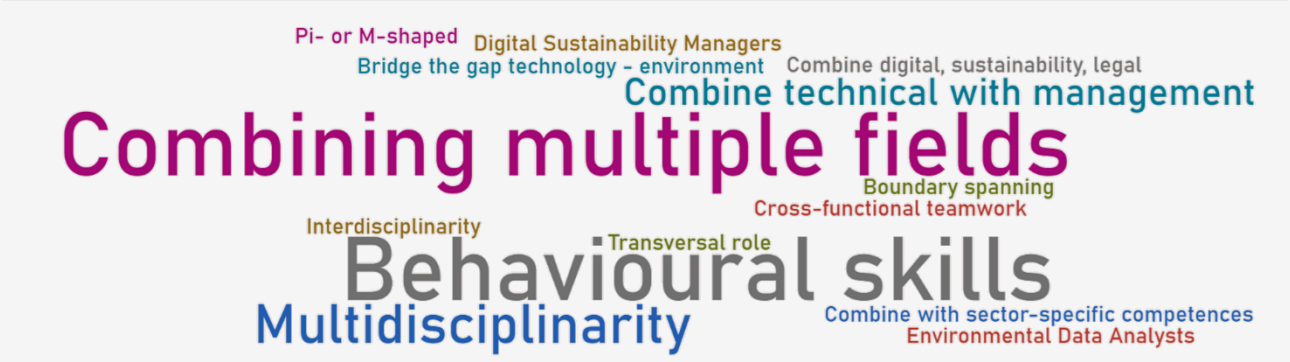

Figure 35 Word cloud of characterisation of digital sustainability role

7.4.1.6 Broader aspects of sustainability

In having to comply with ESG reporting obligations, unfortunately **broader aspects of both climate issues and social-ethical issues seem to fall outside the scope currenty**. The desire and need to broaden the scope are explicitly expressed by a number of experts. The focus on the carbon footprint is far too limited; as smart cities, for instance, already deal with broader climate aspects (e.g., air, water, soil quality). **Jobs applied to digital cities, water management, IoT, material flow management, data security**, etc. will be needed [FR]. Currently, the focus is too much on production and purchase of hardware equipment, while aspects such as lifecycle assessment, circular economy, waste and end of life [BG,FR], but also appropriate use of appliances and hardware, clean coding and the interaction between software and hardware remain underexposed [IE]. Reference is also made to socio-ethical aspects in relation to AI [FR] and to IT in general [RO,SI], referring to the 'do no harm' principle [RO]. **These aspects must get attention in defining skills and roles related to digital sustainability** [BG,FR,IE, RO,SI].

7.4.1.7 Factors accelerating uptake and clarifying the topic

When discussing the roles, there is a significant amount of reference to the need for **education and training** and adjustments to its current set-up [HR,FR,ES,IE,RO]. The details are discussed in the *Education section* of this analysis. In line with this, another role named as very important is that of the **digital sustainability teacher**, who can educate others in digital sustainability [ES].

The importance of **government action** is also indicated. National governments can provide financial incentives and regulations to explain the concept and encourage uptake [BG,IE,ES]. However, opinions regarding regulation are divided; some are in favour of more regulation and see it as a means to promote sustainability [BG,ES], while others have reservations about this and point e.g. to dangers of overregulation and window dressing [IE] and having to deploy scarce resources, which is already difficult for many companies in ESG reporting, especially SMEs [SI].

One role that could drive the process internally is that of **a (digital) sustainability champion, someone who is responsible for the communication** regarding the concept of sustainability, dedicated to improving this area within the company, engaging and informing other employees, including the decision makers; possibly operating in cooperation with HR [HU]. In the long term, this approach could go hand in hand with a **sustainability change management role** to support

the transition across the whole organisation. On a more fundamental level, shifts in thinking and business models are needed for organisations to understand their sustainable transformation. One needs to incorporate **sustainability thinking** to raise aweness for reaching non-monetary goals [NL].

It is suggested that the IT sector itself should take the initiative to develop sustainability policies first, and then assist other sectors, as green practices can provide competitive advantages and leverage a country's natural appeal [BG].

7.4.1.8 Reservations and obstacles

While nobody denies the importance of the topic, there is also **reluctance** and the subject is even viewed somewhat cynically. It is often mentioned that SMEs in particular **lack the budget and people** to really invest in sustainability [HR,ES,HU,IE,RO,SI], that there is a **lack of clarity** regarding the content of the concept of sustainability and what this means for organisations [EE] with respect to their ICT [ES,RO] and what it concretely delivers in terms of USP and commercial benefit [IE]. The **need for a clearer legal framework** is also expressed [RO]; companies should have a specialist with expertise in the specific legislative framework. To organisations, sustainability is a complex and abstract topic, with significant challenges in making these concepts clear and actionable [EE].

Uncertainty towards the future also plays a role; the question to what extent sustainability will really become an important issue makes companies reluctant to invest [ES]. Part of what companies do now in this area is therefore sometimes simply window dressing to be able to tick the mandatory box with as little effort as possible [IE].

So, it is a **balancing act** [HR,IE,RO]: how much to do as an organisation to comply with legislation and public image versus keeping the investment as low as possible given the high uncertainty and other priorities.

For the next 2 years, several experts expect companies to monitor the sustainability trend for now, meanwhile complying with regulation with the deployment of as few people and resources as possible [BG,HR,IE]. They expect current staff will have to perform tasks in this area and there won't be any major changes for the coming years [IE]. For now, this period is considered a first phase [SI,HR], which could grow into something bigger and more permanent. On the other hand, there

are experts that anticipate a considerable surge in demand for roles that integrate sustainability with digital capabilities [IT].

At the same time, it is argued that **having a sustainable image** is attractive when **attracting new, especially young staff** [BG,NL] and also that this image is **appealing to more conscious customers** [BG,HR,SI] and even that integrating sustainability principles into digital transformations will become a key differentiator for **enhancing reputation and competitiveness** [BG,IT]. In the end, it is expected that sustainability will become an organisation-wide responsibility, regardless of organisation size and sector [IE].

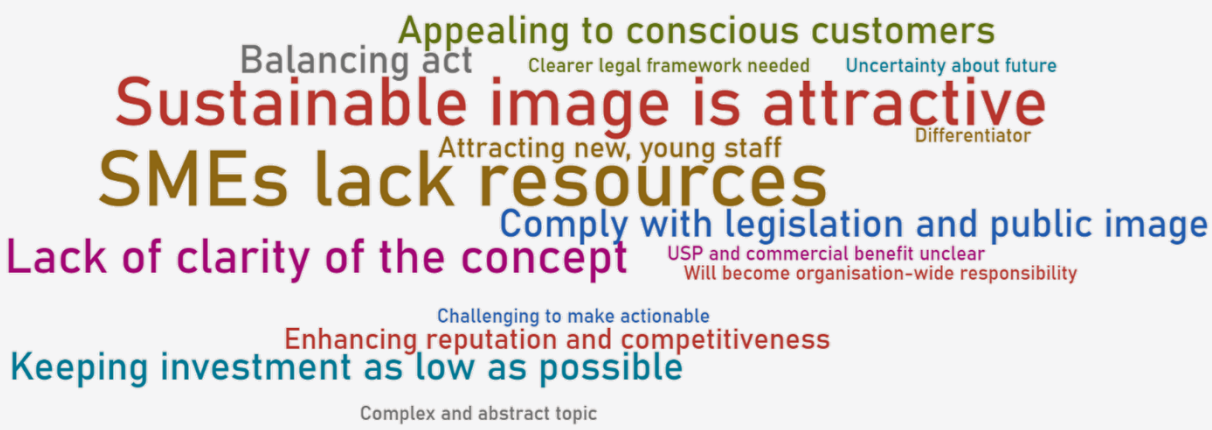

Figure 36 Word cloud of the current narrative surrounding the sustainability topic

7.4.2 Roles needed in the future

7.4.2.1 Drivers

It is indicated that **regulatory pressure** will require companies to continue paying attention to digital sustainability [BG,HR]. The influence of **technological advances** and the further **development of tools** are also mentioned as factors [BG,HR]. But even more than in the short term, reference is also made to the fact that creating and having **a sustainable image** will become increasingly important [BG,HR,IE]. Not only for customers [BG,HR] and shareholders [BG], but certainly also for the attractiveness of the organisation in the context of recruiting/attracting new talent [BG,IE]. Many, especially young people, are personally convinced of the importance of sustainability and prefer to work for an organisation in line with their own beliefs [IE].

Specific drivers currently mentioned are: **the digital product passport** [BG,ES], the **European Green Deal** [BG], the integration of **AI and machine learning** into sustainability strategies [BG,ES] and the **digital transformation** trend in general (e.g. big data, digital twins) [BG]. **Compliance with European and international standards for sustainability reporting**, such as the non-financial reporting directive and the EU taxonomy [BG], is also mentioned.

7.4.2.2 Business as usual: Sustainability as a transversal skill

Furthermore, it is also expected that sustainability will eventually be an automatic part of all business operations, 'business as usual' [HR] and that this trend will be perpetuated on a global scale [ES]. Experts predict an **integration of sustainability into all organisational functions** [BG,HU] in the long term. In that respect, experts see **sustainability itself as a cross-cutting, transversal skill** [BG], to be **integrated into all roles and processes** within organisations [BG], with sustainability being an issue that should not be addressed by just one person, but should be addressed at the level of the whole company [HR], starting with the board of directors [HR].

7.4.2.3 Digital sustainability roles in the long run?

When it comes to determining the importance of specific roles in the long term, some expert panels do not explicitly address this and consequently a number of reports do not mention specific roles [HU,IE,IT,RO]. However, panels do stress the absolute importance of both digital and sustainability [BG,HU].

Many expect an **increase in demand for digital sustainability roles** [BG,HR,ES,HU,IE,RO], but how exactly this will play out is generally fraught with **uncertainty**. A number of countries say that companies will **first focus on the digitalisation transformation** separate from sustainability [RO] and that conditions for many companies are **uncertain** given developments in IT, especially AI [ES,RO]. Companies will have to adapt to this before digital sustainability roles will be in demand [RO]. A number of other panels do mention specific roles, mainly based on **extrapolation of current trends** [BE,BG,HR,ES,FR,SI] and only a few also mention **new roles that do not yet exist** [FR,NL]. The next section discusses the roles and characteristics in more detail. Many panels also

discuss the content and design of education and training when discussing roles in the long term [ES,IE,IT,RO,SI]. This topic is addressed in the *Education and Training section*.

7.4.2.4 Roles and characteristics

A number of panels identify the following specific roles that will emerge in the long term. First, these include **digital sustainability consultants** [BE,BG,EE,SI], especially for SMEs [BE], both in ICT companies and non-ICT companies [SI], due to the fact that it is more cost-effective for them than having in-house experts [BE]. **(Business/ solutions) sustainability analysts** [BE,FR] are also mentioned, especially from sustainable service providers and from larger companies, due to legal obligations [BE], focusing on analysing the relative benefits of sustainable solutions [HR,FR]. Some panels also foresee an increase in the demand for technical roles like **software developer for sustainability** [BE], **ICT sustainable software developers** [IE]**/ administrators** [IE]**/ architects** [IE], **systems administrators** trained in hardware impact and resilience [FR], **intelligent energy systems architects** [FR], and roles related to **smart cities** [FR]. The need for **digital sustainability leaders** [BG,ES] and **digital sustainability managers** [BG] is also reported. A **sustainability data scientist** is also mentioned [BE].

It is expected that there will be **a central key managerial role** [FR,NL] without deep expertise but who can connect the dots [FR]. This would be a **new C-Level role**, **a Chief of Execution (CoE)** [NL] someone who oversees transformation and cross-departmental or even cross-organisational alignment changes, this could include overseeing business process redesign [NL]. In addition, the CIO is expected to play a more active role as there will be more sustainability programmes and action plans [FR]. The need for **digital sustainability leaders** [BG,ES,HU] and **digital sustainability managers** [BG,HU] is also reported. A **sustainability officer** [RO] and **a sustainability champion** [RO] are also mentioned; the latter being an 'agent of change,' someone who specialises in internal communication and can effectively spread the message about sustainability [RO].

Furthermore, roles are expected to be **multidisciplinary** [IE] and a multidisciplinary team is needed [IE]. Profiles should combine expertise in environmental sciences with knowledge in other fields (e.g. HR, accounting, legal) [BE]. They will be a mix of pre-existing management skills and new sustainability skills [BE]. In any case, new roles integrating digital and sustainable skills are

expected to emerge [IT,NL], as not all skills can fit into existing job roles that still need to be carried out [NL].

It will become increasingly important to understand what data is needed for the twin transition in ecosystems, so a new area will be the **'economics of data sharing'** in five years' time, which may also lead to new roles in this area [NL].

In addition, **someone with deep knowledge of environmental and social impact factors** will be needed [FR], an expert who can offer **specialised knowledge and consultancy services**, due to the introduction of new regulations [EE]. This latter person is very important and even crucial for a successful digital sustainability transformation [FR], as this transformation cannot be realised to its full potential without a thorough understanding of the impact the digital has on the physical world.

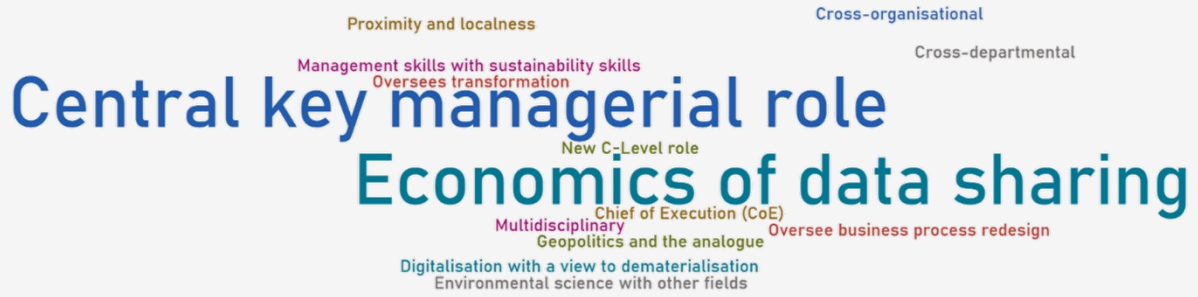

Figure Word cloud of characterisation of digital sustainability role (long term)

7.4.2.5 Reintegration of the physical: A discourse change

Impact factors should be considered much more broadly than the limited 'carbon footprint', which currently receives disproportionate attention. Impact analyses should also take **geopolitical aspects** into account, which then involves how **supply of materials and equipment** is realised [FR]. This requires an almost **paradigmatic shift** from a discourse that now focuses entirely on digitalisation and dematerialisation to one that also includes this material and physical dimension [FR]. Aspects such as **proximity, localness and the analogue need to be reintegrated**. Only this **awareness of the analogue infrastructure behind the digital level** will lead to a change of focus and of business models. It is argued that **it is only in this way that the digital can become truly sustainable** [FR].

7.4.3 Skills needed now

7.4.3.1 The focus: Digital for sustainability or sustainable digitalisation?

Most panels focus on digital sustainability skills in relation to the environment and climate, with discussions around topics such as carbon-neutral and energy-efficient systems, ecodesign, green coding and waste [BE,BG,FR,HG]. This means that the **focus is more on the development and implementation of sustainable systems rather than on systems for sustainability** in the sense of supporting the wide range of issues covered by the SDGs.[12] This is attributed to a **lack of understanding of the term sustainability**, that is often equated with only environmental protection, leaving out big social themes, big resilience themes and big economic themes [FR]. This goes hand in hand with a **lack of understanding of the impact** of digital technology, with the negative impact little or not understood and the positive impact almost never exploited [FR].

However, a few panels mention some aspects that go beyond climate coverage, namely: smart, ethical and inclusive data collection to **reduce biased information** [BE], taking into account **human aspects**, such as **employee health and welfare** [RO,SI] and creating digital content in a way that does **not exploit the psychological weaknesses of the public** [SI], starting with **a responsible design** of digital services (including AI) [FR], e.g. in line with **e-accessibility** principles [FR]. Two panels explicitly acknowledge that sustainability is indeed **a very broad topic** [FR,SI] **with big social themes, big resilience themes** and **big economic themes**, in particular sharing, cloud, etc. [FR].

7.4.3.2 Skills related to transformation

Some panels describe how they expect (or hope) the digital sustainability transformation will unfold in the coming years [BG,HR,FR,IT]. The skills required may depend on the particular stage of that transformation. In one scenario, the first stage is **awareness raising**, to make people aware of their actions in the context of sustainability and having a sustainable business, also supported by digital skills [HR] and that a **strategic approach should be developed** to support companies, from SMEs to large enterprises, in achieving their sustainability and digitisation goals [IT]. Then,

[12] In terms of CODES' Action Plan: currently, the focus is rather on Shift 2 'Sustainable Digitalisation' and not so much on Shift 3 'Digitalisation for Sustainability'. See: Coalition for Digital Environmental Sustainability (CODES). 2022. Action Plan for a Sustainable Planet in the Digital Age. https://doi.org/10.5281/zenodo.6573509

new skills can be educated and trained and existing skills improved for the long term, to develop a workforce that acts in a sustainable way [HR, IT].

Other panels describe a scenario at the organisational level, starting with the **planning of digital sustainability projects** (driven by engineers [FR] or IT professionals [BG]), **assessment of their own company's digital footprint** that results in **developing a strategy** [FR,BG]; followed by an implementation phase [FR], that requires more **managerial skills**. Roles are expected to emerge during that process [BG].

Based on these few scenario descriptions, it can be tentatively concluded that there are different starting points when it comes to digital sustainability transformation. While sometimes awareness-raising is needed as a first stage to explain the concept and its relevance and importance, in other cases companies are mainly dealing with issues related to practical implications; such as planning and implementation.

7.4.3.3 Reporting and legislation

The number one skill that panels refer to most are skills related to reporting and legislation [BE,BG,ES,FR,HU,RO,SI]. In general, expert panels refer to the importance of **reporting skills** related to ESG [HU,SI] and European legislation [BE,HU]. In line with this, the importance of **understanding environmental policies** [FR], **environmental legislation** [BG,FR,SI] and **legislative/regulatory frameworks** in general [ES,HU] are also often mentioned. The latter, by the way, is not only considered important in the light of reporting but certainly also crucial to ensure that digital solutions comply with legal standards [BG] and to reinforce sustainability credentials [BG]. **Compliance** may relate to CSRD, EMAS, ISO 14001, etc. [FR].

The question then arises as to **who should possess this legislative expertise and to what extent**. Panels differ on this. In some panels the experts agree that all IT professionals should have this knowledge [BG,ES], and legislation is seen as a transversal competence [ES]. Other panels explicitly state that those in charge of reporting should also have an understanding of regulations and the bigger picture [BE], without a thorough knowledge of the law [BE]. There will be separate legal profiles, legal experts, who will provide support on this point [BE,RO,SI].

In one panel, the experts argue that those who prepare the reports are best combining these skills with the skills of a sustainability solutions designer or sustainability software developer [BE], as

they need to understand what to report on and how [BE], while this is contradicted in another panel, which states that for developers, reporting and legal aspects are not relevant [HU], and that these are more issues that suit digital sustainability leaders and managers [HU].

So, the discussion around legislation is also about how deep one's knowledge of it should be. Some overall knowledge of the regulatory framework is generally seen as necessary for all digital sustainability professionals [BE,BG,ES,SI] and if not, then at least the leaders/ managers should have this knowledge [HU].

This also touches on a broader discussion: who should possess which skills? This is a question sometimes asked explicitly, 'Does everyone need all twin transition skills, or does it depend on the role?' [NL] but also implicitly raised, given that panels make different statements among themselves on this point.

7.4.3.4 Multidisciplinarity and interdisciplinarity

A number of panels emphasise that having a **multidisciplinary** [BE,FR,IE,NL] and/or **interdisciplinary** [HR,FR] **skillset** is important for digital sustainability professionals. Combinations mentioned are: (basic or general) management skills [BE,BG,ES,FR] or project management skills [BG,ES] together with skills in other fields, e.g. sustainability principles and practices in general [BG,HU,SI], legislation [BG,ES,HU,SI], and different fields like marketing, communication and innovation [FR], so skills in different categories; technical, strategic and intercultural skills [FR].

One panel even suggested that this multidisciplinary skillset might be represented in a separate boundary-spanning role [NL].

It is generally stated that roles in digital sustainability are multidisciplinary in nature. For example, *managers* should have some level of knowledge of technology and **understand how technology can be used** and even **have the ability to develop sustainable solutions** [FR]. The opposite is also suggested: the *IT professional* should have **management skills** [BG] and be able to **contribute to the company's digital sustainability strategy** [BG]. *Business analysts* must **understand the sustainability process or reporting process** and have **insight in the sustainability tools and solutions** and how these can be implemented [HU].

7.4.3.5 Technical Skills

Technical skills that are mentioned several times are those related to **energy-efficient technologies** [HU]/ **energy-efficient computing** [IT]/ **sustainable software and ICT** [BE,HU,IE], sustainable data architects would need these skills [BE]. One panel considers both the ability to design, implement, and manage **energy-efficient IT infrastructures** and the ability to develop **energy-efficient software,** crucial [EE]. These skills are needed to **build IT systems efficiently** [BE]. This relates to *technical specialists* in the field of sustainability [BE], and at least for the *sustainability software developers*, involved in **optimising code and infrastructure** to reduce energy usage and developing energy-efficient software [HU]. So, new **sustainable software coding skills** are required; a better understanding on how code interacts with infrastructure, end users and telco [IE].

Specific key technical skills listed are: **eco-design** [BE,FR,HU], **green coding** [BE], **IoT technologies** [BG,FR]**, programming languages** (e.g. Python, Java, C++) [BG,FR], **cloud platforms** (e.g. AWS, Azure) [BG], **Edge/Fog Computing** [BG], and **AR/VR development** [BG] for *sustainability software developers and engineers* [BG]. In particular, **skills related to smart cities** will be needed [FR], like **IOT, sensor networks, quality measurement, water, air and soil quality.** Likewise, also the ability to **manipulate massive amounts of heterogeneous data**. An **understanding of the tools or solutions to make smart cities more sustainable**, will be needed for people in public procurement**.** Skills in **eco-design** and **electrical and electronic equipment waste** are also important [FR] and **implementing digital solutions for sustainable supply chain management** [IT].

Figure Word cloud of technical skills (short term)

Data skills are also often mentioned as important [BE,BG,HU], if not essential [RO] and relevant for all IT specialists [BG,ES,RO] in general to track and reduce environmental impacts [IT], to make informed sustainability decisions [BG,EE], and also when it comes to **smart, ethical and inclusive data collection to reduce biased information** [BE]. Particularly mentioned are expertise in **data monitoring** [HU], **data collection** [BE,RO], **data management** [RO], **data analysis** [BG,EE,ES,HU,IT,RO], **data validation** [RO] and **data visualisation** [BG]. **Sustainable data center management** is also listed as a needed skill [IT].

Figure Word cloud of technical skills: data (short term)

7.4.3.6 Sustainability related skills and knowledge

It is argued that **understanding sustainability frameworks** is important for all *IT professionals* [BG,HU]. Also, being familiar with **sustainable practices** [BG,SI] in general to incorporate environmentally friendly approaches into digital solutions [BG] and rejecting projects that encourage waste [SI]. Topics mentioned in this context are: **ESG understanding and acting on it** [SI]**, environmental management** [FR]**, life-cycle analysis** [BG] and **circular economy models** [BG,FR,SI], the importance of the **value chain** [FR]**, circular systems** [SI]**, acting on legislation related to electronic waste management** [FR,SI] and **striving to maximise waste recycling** [SI].

The majority of panels mentioned having an understanding of **sustainability impacts and the principles behind** them as important [BE,BG,ES,FR,IT,SI], such as **climate change** with **cause-and-**

effect relationships [BE,BG], the capacity to **measure and valorise impacts** [ES], and an **understanding of broader environmental and social impacts** [IT] or **environmental, social and economic impacts** [SI]. This also implies a **holistic and interdisciplinary design approach** [HR]. Impact understanding, measurement and analysis is the basis for targeted action and policy by companies and governments and thus an essential component for the success of the digital and sustainability transformation. Unfortunately, experts note that there is a lack of understanding in this very area [FR].

Figure Word cloud of sustainability related skills (short term)

7.4.3.7 Management related skills

Experts from different panels see a need for **management skills** [BE,ES,FR,BG], which may include basic management skills [BE], general management skills [FR], project management skills [BG,ES], team management skills [ES], and change management skills [ES], including management of uncertainty and risk [ES,FR], to successfully implement initiatives [BG]. Skills in producing the **strategy and governance** are relevant for the *internal lead* or *external consultant* [BE]**. Risk** may become an important topic; with issues like environmental management control, economic and legal risk in ecological transition, global risk analysis and the transposition of CSR risks into banking and insurance risks [FR].

Figure Word cloud of management related skills (short term)

7.4.3.8 Transversal/ soft skills

In addition, **transversal skills** [IE] and **soft skills in general** are also mentioned [BE,ES,HU] or some specific types of soft skills [BE,BG,ES,FR,HU,NL,RO], which are important for any role in sustainability.

A third of the panels also mention (strong) **communication skills** [BG,ES,FR,HU,NL] and **collaboration skills** [BG,NL]. Both skills are considered essential for stakeholder engagement [BG], awareness raising [FR] and user/customer education [FR].

Other skills mentioned are: **innovation skills** [BG,ES], **problem-solving skills** [BG] to tackle complex sustainability challenges with creative solutions [BG]; **critical thinking** [ES]; **strategic thinking** [HU], **adaptability** [HU], **learning ability** [HU], **intercultural skills** [FR], **organisational awareness** [NL], **situational awareness** [NL] and **understanding of interdependencies** [NL].

More personal attributes are also highlighted, such as **empathy** [BE], **engagement** [ES], **personal commitment** [HU], **taking responsibility** [ES], **sensitivity** [NL] and **credibility** [HU].

Some striking skills mentioned are: **anticipatory skills** [BG] to introduce and manage carbon-neutral systems within their organisations; the **ability to think horizontally**, i.e. constantly align actions with the overall strategy of the company [HU], and the **ability to unlearn** [RO], considered equally important, as employees will have to perform different tasks than they are used to [RO].

Figure Word cloud of soft/ transversal skills (short term)

7.4.4 Skills needed in the future

7.4.4.1 Sustainable IT or ...?

Similar to the short-term, also in the long-term, the descriptions in the reports focus mainly on climate/environment [BE,BG, HR,HU,IE], mentioning topics such as circularity [BG,ES,HU,IE], carbon neutrality [BE], green IT [HR] and energy-efficient technologies [HU].

A few [FR,ES,RO] address **broader sustainability principles** and discuss the **regenerative economy** and its feasibility [FR]; they see a movement from carbon measurement alone to a much more global measure with changing impact factors. They expect that it will be necessary to develop digital solutions that have **a net positive impact** on sustainability and not just focussing on reducing the carbon footprint [FR]. This means there will be a need for people who can **take those impact factors into account** and who know and **apply methods, tools, input data and perimeters to make global measurements** [FR], so an **understanding what data is needed** for **twin transition in ecosystems** [NL]. There will be a trend towards an **industrialisation of data management** [FR], or as another panel puts this: the **'economics of data sharing'** [NL] and this will lead to more sustainability programmes and action plans [FR]. It is also pointed out that **corporate culture** should support **humanity** as part of the broader strategy [RO] and that other regulations for **social sustainability**, such as **digital accessibility**, should not be overlooked [ES].

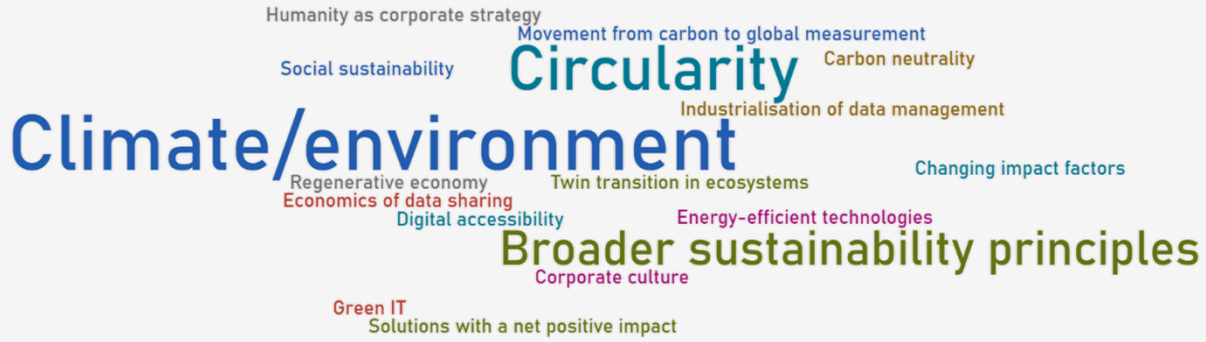

Figure Word cloud of future vision of digital sustainability

7.4.4.2 Drivers

Overall, experts expect an **increase in demand for digital skills in sustainability** [BG]. This is fuelled by legislation [BG], especially to provide sustainability data [BG,IT], an awareness among society and consumers [HR] and the fact that sustainability thus will become a more integrated part of organisational strategies and activities [HU], as companies will focus on actual implementation [BE].

At the organisational level, the following prerequisites are mentioned for a successful digital sustainability transformation: A **holistic approach** to sustainability and digitalisation, as they are not separate goals, but rather interconnected challenges [IT]; An **adaptation of business models** to stay aligned with the market [RO]; A **supportive culture** to support humanity as part of the broader strategy [RO]; **Finding common ground** between business staff on one side and environmental scientists on the other [BE]; **Collaboration between different departments** to avoid the risk of sustainability becoming the goal of only the sustainability team [BE]; and an **awareness of EU funding** related to digitalisation and sustainability is also mentioned as supportive [ES].

In 5 years, many experts expect the **focus to be on the implementation phase** and on **successfully managing sustainability transitions** within organisations [BE,BG], by that time anyway, sustainability will be more integrated in organisations [HU]. It is essential to make sustainability practices a core part of the company culture, particularly in SMEs where hiring new staff is not always possible [BG]. Sustainability itself is actually a transversal skill that should be integrated into all roles and processes within organisations [BG].

In the longer term, experts also expect that more consideration will be given to the entire supply chain [FR,IE]. Related to this, procurement management [FR] will play an important role with skills in **sustainable digital procurement**, as the environmental and social impacts of digitalisation stem from the supply chain and production, and are therefore closely linked to procurement management [FR]; some organisations are expected to change their ICT procurement requirements and will buy only from recognised organisations who have a 'sustainable first' digital model [IE].

This is also reflected in the skills that experts name for the longer term. The skills mentioned by the panels are partly skills related to this implementation in the organisation and partly skills that focus on further impact measurement and data management.

7.4.4.3 Soft/transversal skills

Especially for the long term, **soft skills** [BE,HU]**/ transversal skills** [IE,ES] are emphasised in many panels [BE,BG,EE,ES,HU,IT,RO]. It is even stated that digital sustainability professionals in all roles will need strong soft skills [EE]. Implementing sustainability principles in organisations requires skills such as **accountability** [BE], **collaboration** [BE,EE], **teamwork** [ES,RO] and **communication** [BE,EE,ES,RO], as departments and teams need to work together [BE] and employees need to be convinced to engage in new sustainability roles [RO]. In the latter respect, **storytelling** is also an important skill. This could be skills for a *sustainability champion* [RO], otherwise *sustainability managers* must **explain the benefits** of sustainability to each individual [RO].

On a personal level, important are: **empathy** [ES], **continuous learning** [BG] and specifically **adaptability,** the latter being mentioned by many expert panels [BG,ES,HU,IT,RO]; necessary to keep up with changing sustainability challenges [BG,ES], **creativity** [RO] and **curiosity** [RO]; **high tolerance**, as not all clients are equally interested in the concept of sustainability [RO]; **critical thinking** [ES], **visionary thinking** [HU] and **strategic foresight** [HU] and having a **systemic vision** of the organisation [ES].

Figure Word cloud of soft/ transversal skills (long term)

7.4.4.4 Management related skills

Implementation also goes along with skills in management/leadership [BG,EE,ES,IT]: **strong management** [ES], **leadership** [BG,EE,IT], **value-oriented leadership skills** with **social engagement** [ES], and **change management** [BG,IT], as digital sustainability initiatives often involve significant organizational transformation [IT] that must be driven effectively across different levels of the organization [EE] and to foster a culture that values sustainability across all organisational levels [IT]. Managers must enforce and monitor sustainability best practices ensuring that sustainability is embedded in the company culture and operations [EE]. It is not only about **management of sustainability projects** [ES], but management itself will change its practices and adhere to sustainability principles, with **sustainable IT project management** [FR] and **sustainable change management** [FR].

An understanding of the market [RO], **incentives** [BG], and **consumer behaviour** [BG] together with **risk analysis** [RO]/ **risk management** [ES] are not only essential to **prepare for changes** [RO]**,** but also valuable for **evaluating the impact of digital sustainability solutions** [BG]. All this goes together with **(strategic) innovation** [ES,RO]; particularly associated with **new forms of data integration to support sustainability** [ES].

Figure Word cloud of management skills (long term)

7.4.4.5 (Digital) sustainability skills

In addition, specific sustainability skills are mentioned: **life-cycle assessment** [BG], **circular economy principles** [BG,IE,ES,HU], **resource aware computing** [IE], **green IT practices** [HR] and **delivery of products within green IT practices** [HR]. Knowledge of **circular economy principles** and the **ability to design for sustainability from the ground up** are considered crucial [HU].

Also, knowledge of **the regulatory framework and all related updates** [ES], including also other regulations for **social sustainability** like **digital accessibility** should not be overlooked [ES].

For *developers*, it is essential to master **advanced energy-efficient technologies**, **integrate sustainability into software development life cycles** and **develop methodologies to continuously improve the environmental performance of digital solutions** [HU]. Besides, skills in **sustainable digital procurement** [FR] will gain importance. Another panel mentions **resource aware computing** and **digital skills in green marketing** and **sustainable finance** [IE].

Figure Word cloud of (digital) sustainability skills (long term)

7.4.4.6 Reporting, impact measurement and data

As in the short term, experts mention **sustainability/ESG reporting** [BG,HR], either advanced [BG] or basic [HR]. This goes along with technical skills in **AI and machine learning** [BG] for *sustainability software developers* [BG], as this is crucial for **improving predictive analytics** [BG] and enabling **automated decision-making** [BG] in sustainability efforts supported by **automated environmental management systems** [FR].

Impact is a key word. It is mentioned in several panels [BE,BG,FR,IT]. Crucial to the long-term success of digital sustainability initiatives [IT] is that professionals must be able to **use data and metrics to measure the impact of their actions and make informed decisions** [IT]. So, impact goes along with **processing and analysing data;** skills in this area are also mentioned by several panels [BE,CR,ES,IT] and are needed to **assess** [CR], **measure** [IT], **analyse** [CR] and **evaluate** [BG] **the impact of digital sustainability solutions** [BG,IT] and **the comparative advantages of those solutions [BG]**. Impact is a multifaceted concept and it involves many factors, like rebound effects, impact transfers, carbon accounting and scopes, carbon neutrality, etc. [BE]. Impact can be measured in terms of consumer behavior [BG], efficiency, cost, and sustainability [CR]. **Privacy** then also plays a role [ES]. Overall, a further professionalisation in the field of **impact measurement and evaluation** is expected [FR]. This **understanding of impact factors** relates to the **supply of materials and equipment** according to the geopolitical situation with a greater awareness of the analogue infrastructure behind the digital level leading to a change of focus and of business models [FR].

When it comes to technical skills, the focus is definitely on everything related to **data** [BE,HR,ES,IT] and **AI/ML** [BG]. Developers need to be skilled in AI and machine learning to improve predictive analytics, enhancing automated decision-making [BG]. Other particular technical skills are not mentioned much. In one panel **5g, blockchain,** and **GenAI** are mentioned [ES].

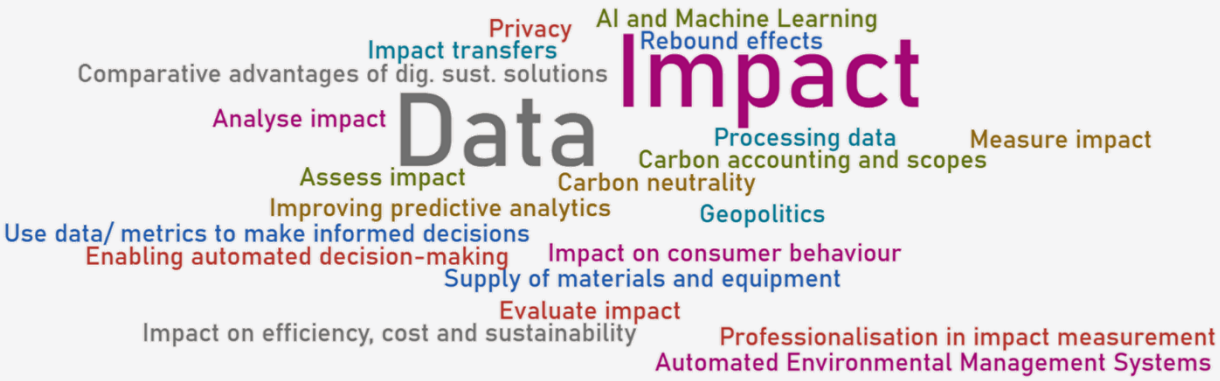

Figure Word cloud of skills in data and impact (long term)

7.4.4.1 Certain skills for certain roles?

In a few panels the experts relate certain skills to certain roles [BE,HU,RO]. In one panel, the experts state that a deep understanding of emerging **sustainability trends** and the changing **regulatory landscape** has to be assigned only to executive positions such as *digital sustainability leaders and managers* [HU]. In another panel, the experts see regulatory understanding rather as a more transversal skill [ES]. In any case, management should have a global **overview of the impact** [BE] and needs to know how and where to act to reduce the environmental impact of their IT infrastructure [BE]. Others argue that *sustainability officers* need to have expertise in **environmental issues** in addition to know-how in **data management** [RO].

7.4.4.2 Skills combinations

There will be a need to combine skills like **data analysis and programming** with an **understanding of sustainability principles and practices**, like **circular economy models, renewable energy technologies, and sustainable product design** [IT]**.** Besides, professionals must understand the **ethical implications** of their work and act on that. This includes understanding issues such as **data privacy, algorithmic bias**, and the **environmental impact of digital infrastructure** [IT]**.** Overall, **multidisciplinary and transversal skills and mindsets** will be a priority [IE].

7.4.5 Education & training needs now

7.4.5.1 Reshaping traditional education?

Many panels begin the discussion by noting that sustainability receives **little or no attention in traditional education** [BE,BG,IE,IT]. In many panels, experts therefore **call for some form of action on the part of formal education** [BE,BG,HR,FR,HU,IE,IT,RO].

It should be **a reform of curricula** [HR], but the panels differ somewhat in the approach; that could be **a holistic approach**, with **full integration** of sustainability in traditional courses and not a simple addition [BE,FR,HU], **embedded as much as possible in full curricula across all subjects** [HU], since the subject of sustainability is holistic by nature and based on the fact that everything is interconnected [BE], which requires a horizontal sustainability mindset [HU]. It could also be an evolution from traditional models to **interdisciplinary curricula merging technology, environmental science and business strategy** [IT]. Actually, education needs to start at **primary and secondary school** to be on the path to sustainability [HR,IE]. Overall, digital sustainability must be part of education programmes, because students who go to school today are the ones who will be in the labour market in the next 2-5 years [HR]. All this could happen gradually, as demand grows [BG].

Others argue that it probably makes more sense to **introduce separate courses/modules** [BG,FR,IE], e.g. a specialisation [FR] or an elective [BG] as part of a BSc programme, short-term courses as part of a track at an IT academy [BG] or existing modules transformed to include a more sustainable focus [IE]. **This is considered a middle ground**, as fully dedicated digital sustainability programmes risk not being attractive to potential students unless the labour market offers a significant number of such positions and this demand is clearly visible to potential candidates [BG].

In one panel [FR], experts differ in opinion on this, **debating the effectiveness of adding courses** to a curriculum versus a situation where sustainability is an integrated part of the full curriculum. Some experts on this panel do not think that adding a few short, specialised courses after a study can really make a difference [FR].

The importance of **integrating real-world applications and case studies** into educational programmes [IE,IT] to give students a full understanding of how digital tools can be applied to sustainability challenges, is also highlighted [IT].

7.4.5.2 A cooperative effort

Many panels indicate **a need for some form of cooperation or synergy between education and industry** [BG,IT,RO] **and government** [BG,IT].

This is driven by the idea that formal education could use support from industry and government [BG]. **The business sector could provide valuable insights** into the skills and knowledge that are most in demand so that the education offer matches the needs of the labour market. Education and training providers need clearly defined requirements and professionals capable of designing the materials and teaching them [BG]. **Government support** is considered crucial to **encourage companies and educational institutions to invest** in sustainability education and training initiatives [IT].

One panel [BG] goes into considerable detail about the elements needed to shape this and distinguishes the following steps: (1) establish strong **industry-education partnerships** involving **universities, schools and academies**, (2) **identify and involve experts** (who are already working in the field and have accumulated enough experience, knowledge, contacts, etc. and are both willing and able to pass that on to others), (3) **create practical training resources and courses** that are essential for developing effective programmes, and (4) **conduct at least one iteration of such courses** at all institutions.

Contributions from the experts involved in this process under step (2) can take different forms. For example, designing courses, designing training materials, conducting training, **'train the trainers'**, forming and maintaining a community of practice, assuming the role of evangelist, etc. **Open courseware** can be developed according to the 'by the IT sector, for the IT sector' principle [BG]. Experts in another panel also mention the importance of **train the trainer** in particular to align educational programmes better with market needs and to close the gap between universities and companies [ES], but teachers or trainers that can teach others are difficult to find [ES].

Figure Word cloud of digital sustainability in traditional education (short term)

7.4.5.3 Urgent training need

Alongside this call for action on formal education, experts on many panels stress the **urgent need to reskill** [BE,BG,HR,IT,RO,SI] and **upskill the existing workforce** [BG,ES,IE,IT,NL]. They consider this the best short-term option [HR] and more practical than setting up dedicated academic programmes [BG].

In general, experts suggest that this should take the form of **short training courses** [BG,FR,IE,IT,SI] with **certifications** [BG,HR,FR,IE,SI] or **micro-credentials** [HR,ES,FR,IE,SI]. The latter are considered essential in this field [SI], matching the training needs in this field [ES] and also easy to keep up-to-date due to their small size [ES]. These could be micro-credentials for a specific sector or interdisciplinary ones [SI].

Training the existing workforce should be **started carefully** [BG,SI], with small steps and 5-6 trainings in 1 year [SI] and it is said that training should be **incremental** [BG]. The necessity for **continuous learning and professional development (CPD)** is highlighted [IE,IT], as digital technologies and sustainability practices evolve, professionals must regularly update their skills [IT].

7.4.5.4 Different types of training and different target groups

In many panels, experts distinguish between **different types of training** [BE,BG,ES,HU,SI]. Mentioned are:

(1) **(short) awareness-raising training** [BG,HR,NL,SI],

(2) **basic training on fundamentals** [BG] and

(3) **more advanced training for experienced professionals** [BG]. This could be **tailored training** in digital sustainability **for specific, already existing roles** [BE,BG,ES,SI], to equip professionals with the skills they need to incorporate sustainability into their daily responsibilities [ES].

Some panels express the need for **basic sustainability and climate change training for all employees** [BG,ES,SI] to build a culture of sustainability within organisations [BG]. However, there is a footnote on **awareness-raising training**[13], that **there should be a follow-up on the practical implications in the workplace** [FR] and that to go further, **MOOCs, trainers or independent consultants** could be used, to train people more precisely on different skills and professions [FR].

Also mentioned is training for **leaders** [ES], **managers** [BE,ES,IE], the **C-suite** in general [IE] and **HR executives** [BE], to get these people involved in the topic and explain what it means specifically

[13] There are already several awareness raising trainings available, like Climate Fresk.

for them [BE]. Actually, **all team leads, unit managers, senior managers and directors** will need short training courses on sustainability [IE]. Experts suggest **short upskiling masterclasses** with access to **case studies of best practices** that could be supported by skills pathways and courses for **decision makers** [IE]. **C-Suite** training is considered critical as these are the people who need to understand national and international sustainability policies and goals and the finance required to execute those requirements internally [IE]. Higher education could develop these training programmes for leaders [ES]. Experts also mention training for **technical roles** [BE,BG,ES], such as **data engineers** [BE], **software developers and engineers** [BG] and **other IT professionals** [BE]/ **specialised technical profiles** [ES] to explain best practices in digital sustainability and to leverage their technical skills to integrate sustainability. For example, an organisation typically with a **CTO** or a **facilities manager** or smaller companies with an **operational manager**, will anticipate immediate training needs for these individuals [IE]. The courses these people will follow will focus on sustainable IT and mainly the hardware [IE].

Experts differ on the point of how specialised those trainings must be. For example, for some roles some experts think that general sustainability education, may suffice, enough to **understand the basics** [HU], like **a sustainability data scientist** [HU]. It is even suggested that it is better to train managers to formulate sustainability related quests to data analysts, than training the analysts themselves. They will perform the query provided to them [NL]. On the other hand, others state that **sustainability data architects** will need to have high level of knowledge in sustainable IT [BE]. For other roles, experts expect a **growing need for dedicated, more in-depth training** [HU] for professionals working in specialised fields such as energy efficiency, waste management, and social sustainability [HU]. The importance of upskilling existing workers rather than hiring new employees is emphasised, as it allows companies to build on their existing knowledge and experience [IT], study plans for employees and managers are important to have in the company [ES].

Several panels also state that training should have a **multidisciplinary approach** [BE] to bridge different disciplines. Training could either be delivered by a **dedicated in-house trainer** [BG] or through **shared roles between departments** [BG]. **Support from senior management** is seen as a prerequisite for success [BG,SI].

Experts expect that there is likely to be **little demand for advanced training in the first few years**. After more years and if interest in the field is still high, demand for advanced training can be expected to increase [BG]. It is also expected that **SME's** will partly use external consultants and partly need to train their own staff [FR].

There are pleas for training to be delivered **not only in universities** [BG], but also in **schools** [BG]/ **primary** [HR,IE] and **secondary education** [ES,IE] and **other educational institutions** [BG].

It should also not be forgotten that besides knowledge of sustainability practices, also sector-specific knowledge is needed. This means that someone working in the sector could be upskilled on the part of sustainability, or someone outside the sector with knowledge of sustainability has to acquire sector-specific knowledge [SI].

Figure Word cloud of digital sustainability training (short term)

7.4.5.5 Key skills for training

Experts also list **key skills that should be included** in training programmes: **understanding environmental regulations** [BG], **sustainability reporting** [BG], **data analytics** [IT], **systems thinking** [IT], **sustainable design principles** [IT] and the **use of advanced technologies** [BG] such as **AI** [BG], **IoT** [BG], **AR/VR** [BG].

Courses and certification preparation in **IoT, Cloud Computing, Edge/Fog Computing** and **AR/VR** are essential for *software developers and engineers* in the field of sustainability [BG]. Training in **AR/VR** enables them to design innovative simulations and interactive tools [BG].

Upskilling and reskilling initiatives for the current workforce are considered especially important in **data analysis** [IT]**, sustainability consulting** [IT], **facilities management** [IE] and **operations management** [IE,IT].

Also, *software developers and engineers* can be trained on sustainability issues to leverage their technical skills for sustainability integration [BG]; and the same is true for *system administrators* [FR]**.** In general, **training the existing workforce** is important [FR]. **Users** also must be trained in the use of these solutions [FR].

In the next two years, it is important **to make people aware** of the way their actions contribute to sustainability and sustainable business, and how digital skills can support that. Then develop new skills and upgrade existing ones for the long term [HR].

7.4.5.6 The future …

In the coming years, **more clarity is needed on what sustainability means** and how it can be implemented. Currently, there is no standardised 'formula' for sustainability and it remains unclear what it will look like in the future [RO].

Meanwhile, **fostering a mindset in which ethical considerations play a role when deploying technology is crucial** [IT] and a **continuous development of digital sustainability skills** among employees will be necessary for an effective implementation [BG] and gradually shaping employees' mentality towards openness, embracing digital change, and adapting to the new environment [RO].

7.4.6 Education & training needs in the future

7.4.6.1 Specialised training

In the long run, many experts expect there will be **a demand for tailored training for various functions in specialised areas** [BE,BG,ES,HU,IE,IT]. Professionals must be equipped with both **technical skills and sustainability skills** [IT]. It is even suggested to standardise these trainings, to streamline onboarding processes, customisation and development of products and services, and provide opportunities for collaboration across countries and industries, including the education sector [BG].

The target groups listed are: **human resources** [BG]**, procurement** [BE,BG]**, leaders** [ES], **C-level executives** [BG], **management** [BE,BG] and **technical functions** [BG], like software developers [BG].

Experts mention a range of possible topics for these specialised training courses:

- Business topics [BE,BG,IE,IT,SI]: **sustainability consulting** [IT,SI], **green project management** [IT], **sustainable IT procurement** [BE,BG], **sustainable supply chain management** [BE], **sustainable cloud computing strategies** [IE]**, new green business models in the cloud** [IE]**, cloud vendor management** [IE]**, green marketing** [IE]**, circular economy** [IE]**,** and **sustainable finance** [IE];
- Technical topics [BG,IE,IT]: **sustainable infrastructure design** [IE]**, sustainable application development** [IE]**, sustainable product design** [IT]**, renewable energy technologies** [IT]**,**

programming [IT]**, data management** [IE] and **data analytics** [IE,IT]**, cloud performance optimisation** [IE] and **AI-driven solutions** [BG];

- Sustainability topics [BE,HR,IT,NL]: **fundamentals of ecology** [HR], **EU policies and regulations** [HR], **understanding sustainability data** [NL], **energy efficiency** [HR], **circular economy models** [IT], **waste management** [HR]**, environmental analysis** [IT], **planetary limits** [BE], **rebound effects** [BE]**, impact transfers** [BE]**, carbon accounting & scopes** [BE]**, carbon neutrality** [BE]**, globalisation** [BE]**, macroeconomics** [BE] and **ethical considerations to ensure responsible decision-making** [IT].

Besides this specialised training, there is a need for a **general sustainability training for all employees** [BG].

Experts provide some additional details:

- A differentiation must be made between training **basic and advanced technical knowledge and skills** [HR];
- **Software developers** are expected to keep their skills up to date on **new AI-driven solutions** [BG]. Particularly they must be flexible and adaptable to change to stay updated and incorporate new technologies in their work practices [BG];
- **Awareness of the supply chain (social and ethical aspects)** should be part of the training in **sustainable IT procurement** [BE].
- **Ethical considerations** should be incorporated into training programmes. This includes understanding issues such as **data privacy, algorithmic bias**, and the **environmental impact** of digital infrastructure. A strong ethical foundation is essential for ensuring that professionals are equipped to navigate the ethical implications of their work and that digital advancements align with broader sustainability goals [IT].
- Training programmes should incorporate **leadership development** modules that focus on **strategic thinking, communication**, and **stakeholder engagement**, as effective leadership is crucial for change and fostering a culture that values sustainability in the organisation [IT].

In one panel the experts have different opinions on upskilling [NL]. Some of the experts argue that it is **not necessary to have all the expertise in-house, nor is specific training and in-house training needed;** it would be enough to have an understanding of the dynamics, requirements and relevance of the digital sustainability transformation, requiring an understanding of **'BLT': Business-Legal-Technical** and **human rights** [NL]. The only upskilling need these experts see is one to **understand sustainability data**, in the light of the collection and analysis of more data

and other data points by financial planning and control departments due to legal requirements [NL].

7.4.6.2 Continuous learning and professional development

Even when experts feel that long-term training needs are difficult to predict [ES], they stress the importance of **fostering a culture of continuous learning** and professional development (CPD) [BG,ES,IE,IT]. This is considered essential to retain a well-trained and skilled workforce [ES] and experts even argue that **mandatory continuous training should become the norm** for all professionals, regardless of sector, to keep their skills up-to-date and relevant [IT]. This mandatory training can be implemented through government policies, industry regulations, or company-level initiatives [IT]. Companies will have to invest in continuous training to ensure employees can adapt to the new required skills [IT].

Figure Word cloud of digital sustainability training (long term)

7.4.6.3 Formal education

Regarding formal education, experts expect **a strong call for formal education pathways** and **comprehensive degree programmes in digital sustainability** [BG], with development of **dedicated BSc and MSc programmes** [BG] and **dual-masters** [BE], that combine sustainability with any other expertise, for example a master's in Eco-Design after an IT bachelor, resulting in qualifications like a sustainable legal expert, a sustainable IT architect, a sustainable communications expert, etc. [BE]. **Secondary and tertiairy education** play an important role in this respect [BG] and education in general is fundamental to equipping individuals with specific competencies, raising awareness about the importance of implementing sustainability and to the adoption of digital sustainability overall [RO].

In addition, it is also argued that the **basics for (digital) sustainability skills and principles should be present in any education and professional training at all levels** [BE,BG,HU], including secondary education [BG,HR], so already **from an early age** [BG], integrating sustainability principles into entire curricula [HU], focussing on creating new professionals [HR]. This **holistic approach** will ensure that students from all disciplines develop a **sustainability mindset** and consider **the environmental, social, and economic impacts** of their future professional activities [HU].
Overall, the hope is expressed for **a switch** from the current approach of training people in IT and making them aware of environmental issues **to a reverse situation** of explaining how IT works in order to use it as a tool for positive and lasting impact [FR].

Practical experience during education and training is considered very important [HR]. This can be implemented in several ways, for example through internships [BE,IT] and apprenticeships [IT] within companies (internships are even considered a must [BE]), using regularly adapted learning outcomes based on practical experience [HR], situational learning [HR] and mentoring to monitor employees' adaptability [HR].

7.4.6.4 Cooperation

Experts point to the **importance of effective collaboration between companies and academic/ training institutes** [BG,IT]/ **public sector** [RO], although it is stated that successful examples remain limited [BG]. Such a collaboration will ensure that curricula are aligned with the evolving needs of the labour market, including providing feedback on required skills, offering internships and apprenticeships, and possibly co-developing training programmes [IT].
One panel suggests the formation of an **advisory board** with academic members to advise on sustainability decision-making [RO]. The experts argue that the academic environment should continuously promote cross meta-skills and research institutes should help develop new digital and sustainability solutions [RO].

7.4.6.5 The future: collective well-being or a 'sustainability debt'?

An IT sector expert expresses the dream of **supporting the elevation of collective well-being through sustainable practices** [IT]. This sentiment underscores the growing importance of sustainability in the business world and the need for training programmes that can equip professionals with the necessary skills to bring about positive change [IT]. Long-term transition requires a change in attitude and behaviour [RO]. So, it all comes down to the essential question: **Are people willing to change their behaviour?** [NL] They might do so when they realise that any current compromise regarding profit over sustainability will later have a detrimental effect with

unintended consequences and they might end up with **a sustainability debt** [RO]. Then finally and hopefully, the discourse will have evolved as well from a focus on sustainable digitalisation to digitalisation for sustainability.

7.5 Annex Summary of national expert panels

7.5.1 Summary of national panels on current role needs

Belgium	Following the **Corporate Sustainability Reporting Directive** (CSRD), Belgian experts expect a rise in demand for people who can generate sustainability data. This means a rising demand in particular for **data architects and data analysts** for creating systems, organising data, reporting and measurement, having a high level of knowledge in sustainable IT, including **ethical data engineers** for smart, ethical and inclusive data gathering (to mitigate biased information). **Sustainability data analysts** are needed if companies opt for in-house sustainability solutions. It is expected that there will be no specific effect on the demand for **sustainability software engineers**; as they can continue to design software regardless of its purpose. A digital sustainability strategy and governance mechanisms can be prepared either by an **internal lead** or an **external consultant**. Ideally, this should be done before the manager and engineer start their work. However, due to various constraints, this does not seem to happen, including the coming into force of the CSRD and having to comply with reporting requirements. As a result, there is no time to draw up a good overall strategy and governance before environmental data has to be collected.
Bulgaria	Bulgarian experts mention the challenges Bulgaria is facing, particularly in traditional industries like construction and manufacturing that are less aware of digital sustainability and are lagging behind in digitalisation. However, in general, many companies lack internal assessments to identify the need for digital solutions and corresponding skillset. This could change by **legal requirements**. Experts also call upon Bulgaria's IT industry, that should develop internal sustainability policies first, then assist other sectors, leveraging Bulgaria's natural appeal. As for the digital sustainability roles that do exist, experts remark that they **tend to be narrowly defined, missing broader strategic integration and continuous skill development.** Experts also point out the difference between the **public and private sector**; roles in the public sector tend to be more compliance-focused, while the private sector prioritise roles that drive innovation and operational efficiency. Early adoption of green practices could provide competitive advantages. In this respect, the **digital sustainability lead, manager** and c**onsultant** are essential when it comes to effective implementation. Experts agree on the fact that digital sustainability **roles related to data processing & analysis and development & operations** should not be considered separately but **must be integrated within their existing counterparts, either as an extended skillset or as an advancement level**. These professionals already possess the necessary technical skills, and with appropriate education, they can effectively integrate sustainability into their work. Additionally, other existing roles should also adopt skills and principles relevant for digital sustainability.
Croatia	As with AI, Croation experts find it difficult to say what will happen in the coming years in the field of digital sustainability.

	Right now, many organisations are in the process of **complying with European requirements** regarding the delivery of their **ESG data.** Companies are performing **a balancing act** between this EU requirement, customer and user requirements, the organisation's ability to recruit staff in digital sustainability roles, impact on operational processes and available budget. For many organisations, employment in these roles is a pure **luxury that only larger companies can afford**. Therefore, the estimate is that this will not change much in the next two years; within organisations, **there will be just 1 or 2 people with tasks** in digital sustainability; monitoring the needs and state of digital sustainability and, in particular, ensuring compliance with EU regulations.
Estonia	Currently, Estonian experts do not observe a shortage of general sustainability understanding within companies; however, the role of digitalisation in sustainability needs more focus. Due to **ESG requirements**, there is at least one person who oversees these aspects in a company. They point out that sustainability is **a complex and abstract topic**, with significant challenges in **making these concepts clear and actionable** within organizations, **involving a philosophy of using resources sustainably and efficiently,** often driven by European regulations. The experts expect a demand for the following roles: **a data analyst with sustainability expertise**; focussing on analysing and leveraging data to support sustainability initiatives, **a sustainability manager**; within the leadership team, being responsible for overseeing sustainability efforts and ensuring they are integrated into the overall business strategy, **a legal framework specialist**; a legal expert who can navigate the evolving legal landscape and ensure compliance**, a consultant in sustainability**; providing expert guidance and support on integrating sustainability into operations and **sustainable data engineers**; designing and implementing data systems that are both efficient and aligned with sustainability principles.
France	In France, experts discuss whether digital sustainability skills should be added to existing positions within the organisation, or that a number of separate positions have to be created. In particular, **environmental managers and ESG reporting managers** are expected to be in greater demand. Functions in which technical aspects will be united with management aspects. Reference is made to issues related to responsibility and sustainability specifically in the field of AI. This is also reflected, for example, in the AI Act and ISO standards, such as ISO/IEC 42001 on AI Management systems. Demand is also expected to rise in supply of jobs in the area of sustainable smart cities. Here, a broad range of many different functions is needed, **jobs related to IoT, sensor networks, environmental quality measurement** and **data processing and analysis.** There will also be more demand for people who can interpret legislation. SMEs will hire **digital sustainability consultants** for this, or train their own in-house staff in sustainability skills. The effectiveness of **sustainability managers** telling others what they are supposed to do is questioned. Experts think it is much more important to train digital sustainability skills in people in existing roles, to develop an environmental viewpoint. They see the need for all kinds of other positions to also have sustainability skills. This applies both to technical IT staff, such as system administration, process automation; and other roles in the organisation, such as digital

	marketing, public procurement, asset management, project management and product management. **BOARD NOTES:** • Eco-manager of AI-related management systems (ISO42) • Jobs applied to digital cities, water management, IoT, material flow management, data security, etc. • Assets Managers hardware impact (procurement and usage) • Administrators of asynchronous and decentralised work systems • Process optimisation / automation - footprint reduction • Reporting Project / product managers • Green Data Manager • Digital solution eco-designer (for architects and developers) • Energy Efficiency Engineer • CSRD Manager • Circular Economy Specialist • Environmental impact measurement manager • WEEE Management Specialist • Green Software Developer • IoT for Sustainability Engineer • Environmental Risk Analyst • Head of frugal AI • Legal specialist, regulatory and standards watch • Digital Sustainability Marketing / Communication • IT ESG Manager • Sustainable Cloud Architect
Germany	For the short term, German experts discuss the demand for sustainability-related roles in the market and how the **demand is shaped by the overall company's culture**. The discussion also dealt with how introducing new roles will be mapped to existing positions and how the **sectoral differences** can be a deciding factor when it comes to the understanding of roles. Experts differ among themselves about the differences between the need for these roles in the **public and the private sector**. One expert sees a clear demand for **digital sustainability manager** profiles especially in the public sector. Another expert does not see much difference between the private and public sector; this merely depends on the sector: There is a sectoral focus on sustainability ecology, in which there is such a difference in roles between sectors especially for upskilling, however in other sectors, the differences between private and public sectors are not significant. Besides sector, also **company size** plays a role in the demand for sustainability jobs: bigger corporations would always have a variety of jobs which are more directed to, for example, specific technical sustainability skills. This is dissimilar to smaller companies which usually have more generic job descriptions. **Consultancy** jobs are expected to be in demand in this field. Overall, it is expected that roles won't develop into jobs in the coming years, as they are evolving rapidly and need constant training. Rather, it is expected that sustainability practices will be woven **into existing IT jobs**.
Hungary	Hungarian experts see definitely a need for several roles in the area of digital sustainability. They mention a **sustainability leader**, who can develop strategies and a **manager** to can implement them. Additionally, they also see a need for **business analysts,** who understand the sustainability (reporting) process and have an insight into tools and solutions and **data scientists,** to continuously monitor and analyse the data. Another role they discern and consider key to the implementation is the role of **someone who is responsible for the communication** regarding the concept of sustainability, dedicated to improving this area within the company, engaging and informing other employees, including the decision makers; possibly operating in cooperation with HR; **a (digital) sustainability champion** *(latter term added by author of the analysis)*. In the long term, this approach could go hand in hand with a **sustainability change management role** to support the transition across the whole organisation.

	Also, the **software developer for sustainability** plays a key role, as sustainable software practices can optimize code and infrastructure to reduce energy usage that reduces the carbon footprint. Likewise, also the **tester** in development and operations must have sustainability skills. In the short term, one expert foresees that these roles will probably be **integrated into existing positions** to ensure digital sustainability is a key focus. Completely new jobs fully dedicated to digital sustainability, as they may sound appealing for marketing and branding purposes are considered unlikely to materialise without strong incentives. Also, digital sustainability roles will likely be seen within **large corporations**. SMEs might not adopt these roles unless specific funding or grants are available. In both large corporations and SMEs, these roles may not have long-term sustainability unless they provide cost-effective and efficient solutions. Initially, there may be strategies aimed at digital sustainability, but their longevity will depend on how well they are integrated into overall sustainability strategies.
Ireland	Irish experts expect **sustainability to become an organisation-wide responsibility**, regardless of organisation size and sector. They also consider it imperative that technology stacks whether owned or outsourced are utilised in a more climate and sustainable friendly way. **External motivation** will certainly help, such as **national policies and financial incentives** from the government, e.g. a system of sustainability vouchers for companies to undertake feasibility studies. The **C-Suite** has a critical role as they need to understand national and international policies and goals, so they can translate this to their own company's context. Due to **regulations**, they suddenly must administer the task of reporting on **ESG KPIs/Metrics**. **In large companies** where decisions are taken centrally, **they cannot just create job roles/profiles locally** as it is all part of a larger process. Currently, **sustainability roles** in organisations either **do not exist**, or just **one person from a from a facilities/operational team has been assigned the task**. The latter is then merely a window-dressing measure to tick off the box of the ESG reporting. Experts point out the danger of **over regulation** and not hitting the intended objectives. Currently, companies do not have budget available to create separate digital sustainability functions. There is **no clear USP** or commercial benefit. This is especially true for SME's. So, **current staff** will have to perform tasks in this area and no major changes are expected for the coming years.
Italy	Italian experts note that the growing recognition of sustainability is driven by **regulatory pressures, consumer expectations and the need to address climate change.** They also indicate that many industries are still in the **early stages** of integrating digital tools with sustainability goals. There is however a broader industry trend towards **embedding sustainability into core business operations.** For businesses that want to differentiate themselves from their competitors, the integration of sustainability principles can be a means to **enhance their reputation and competitiveness**, while facing increasing pressure from stakeholders. Several participants state that this trend will not just lead to the **creation of new roles** but will also **redefine existing positions**, with the inclusion of sustainability competencies in traditional IT roles. They anticipate a considerable rise in demand for roles that integrate sustainability

	with digital capabilities, with a focus on **consultancy, operations, and data analysis**, indicating a shift towards more data-driven decision-making processes in sustainability efforts, such as **sustainability consultants, data analysts**, and **green operations specialists**. There will be a need for **interdisciplinary roles**, such as **Digital Sustainability Managers** or **Environmental Data Analysts**, who can bridge the gap between technology and environmental stewardship. Industry should collaborate to establish standardized role definitions and competencies.
Nether-lands	In the Netherlands, the experts debate on the importance of understanding socioeconomic paradigms, shifts in thinking and business models that is needed for organisations to understand their sustainable transformation. One needs to incorporate sustainability thinking to raise aweness for reaching non-monetary goals, not also for the company. The economics of data will become important and there will be a need for an **ESG-business strategist** role. Further, experts discuss the need to have all digital sustainability skills in each person, or are these skills role-dependent? Should everyone have digital sustainability capabilities or is it more a **boundary spanning role** at every department? This person is responsible for digital sustainability across departments. The **multi-disciplinarity** of this role is also emphasised by considering them as T-Pi-M shaped professionals, where the M consists of digital, sustainability, and legal aspects. Besides technical aspects, behavioural aspects are equally important in this role. It is stated that it is more important to train managers to formulate sustainability-related quests to data analysts, than to instruct the data analysts themselves. Being a sustainable organisation, or having this image, does help to **attract new staff:** young people like working for an organisation that has this image of being sustainable.
Romania	Romanian experts point to the **ambiguity** surrounding the concept of sustainability. They express the need for **a clearer legal framework**. Each company should have a **specialist with expertise in the specific legislative framework.** Currently, companies have very little know-how on digital sustainability. When it comes to sustainability, large organisations play a crucial role. Smaller organisations are much more concerned with survival and rather put profit before sustainability. Experts expect rising demand for **consultants** that support decision makers in their sustainability decisions and act as gatekeepers; filtering incoming offers and selecting the best ones. Demand is also expected to rise for **digital experts**; systems engineers and digital transformation experts in general. Here, according to experts, the social aspects of digitalisation should also not be lost sight of; the 'do no harm' principle, which is also part of digital sustainability.
Slovenia	Currently in Slovenia, the roles of the **(digital) sustainability transition advisor/consultant** and of the **(digital) sustainability manager** are relevant. This is especially true for large companies, which employ a **sustainability manager** responsible for **ESG reporting**.

	There are many SMEs in Slovenia, and for SMEs, however, ESG reporting is a big challenge. This could be solved by training a pool of **digital sustainability consultants**, who could then be hired by SMEs. On the other hand, there are sector specific topics that need to be taken into account as well. It is also argued that the **social aspect of sustainability** is often forgotten. If a company really wants to compete, it must have someone with **a holistic view** on sustainability. There is an awareness of sustainability among the companies' customers that forces companies to put the topic on the agenda. Currently, employees within ICT companies are gaining knowledge on sustainability. Experts consider this the first phase in what could become a bigger process.
Spain	In Spain, sustainability is an emerging concept and the demand for people in (digital) sustainability roles is rising slowly. There are many SMEs that have more trouble moving along in this than large companies. It is also **unclear** exactly what sustainability in IT means and how this should then be translated into roles. Currently, many organisations have no real internal policy on workplace sustainability. **Teachers** that can teach others in this topic are very important, but are scarce. The demand for digital sustainability roles is expected to rise **if regulation intensifies**. Experts think that digital sustainability roles **will not become separate functions**, but rather will be **assigned to existing functions.** The **leadership role** is important to guide others in this. Experts note an emerging demand for **consultants in sustainability** and possibly **data processing and data analysis experts**. In any case, roles should be transversal and multidisciplinary and promoted by top management.

7.5.2 Summary of national panels on future role needs

Belgium	In the long run, Belgian experts see a need for profiles that combine expertise in environmental science with knowledge in other fields (i.e. HR, accounting, legal). They will be a mix of already existing managerial skills and new sustainability skills. Ideally, they should possess the skills to become **digital sustainability consultant, sustainability data scientist, sustainability solution designer, software developer for sustainability** and **sustainability business analyst**. Among SME's there will be a demand for **digital sustainability consultants**, being more cost-effective for them than in-house experts. Demand for (digital) sustainability roles will come from sustainable service providers and from larger companies, especially for **sustainability business analysts,** due to legal obligations.
Bulgaria	Bulgarian experts emphasise the growing importance of digital sustainability roles driven by regulatory requirements, technological advancements, and the need for comprehensive integration of sustainability across all organisational functions.

	They highlight several drivers that they expect to stimulate the demand for digital sustainability roles, such as EU regulations (e.g., digital product passport) and policy (e.g., EU Green Deal), the integration of AI and machine learning into sustainability strategies and the digital transformation trend in general (e.g., big data, digital twins). But also meeting customer and shareholder expectations, and attracting employees who prefer working for sustainability-focused firms are aspects that play a role. Specifically, compliance with European and international sustainability reporting standards, like the Non-Financial Reporting Directive and the EU Taxonomy, is creating a need for roles such as **digital sustainability leads, managers, and consultants.** In their opinion, sustainability itself is a transversal skill, that should be integrated into all roles and processes within organisations
Croatia	Experts in Croatia expect a rising demand for people in digital sustainability roles. Companies will necessarily have to adapt, both to the laws and to the demands of their customers. Currently, there is a great demand for **sustainability officers and managers and similar roles** in order to stay compliant with regulations. However, sustainability is not a topic that should be dealt with by just one person, but it is a topic that should be addressed at the level of the entire company. It should primarily be dealt with by the executive board, and then by the people below. Experts expect an increase in demand for employees in digital sustainability roles as a result of the development of tools and the growing importance of the digital sustainability topic. Important aspect of those roles is analysing the comparative advantages of sustainable solutions. In 10 years, digital sustainability will be business as usual.
Estonia	Regarding the long term, the Estonian experts expect a demand for professional experts who can offer specialised knowledge and consultancy services, due to the introduction of new regulations.
France	In the longer term, French experts foresee the need for several roles related to sustainability: Firstly, **a central key managerial role** without in-depth expertise, but who can connect the dots; then **someone with in-depth knowledge of environmental and social impact factors** and thirdly, **analysts** for solutions proposed in sustainability programs. The CIO will play a more active role because there will be more sustainability programs and action plans. One of the experts stresses the importance of **a person that understands impact factors**, particularly in relation to the supply of materials and equipment according to the geopolitical situation. This expert calls for a reintegration of the material and physical dimension related to aspects of proximity, localness and the analogue as opposed to the trend of digitisation and dematerialisation. Only an awareness of the analogue infrastructure behind the digital level will lead to a change of focus and of business models. Experts argue that only with this change in the discourse, the digital can become truly sustainable.

	BOARD NOTES: • Global digital manager • Risk manager (procurement, impact factors, etc.) • Digital medicine • Digital city: modelling water, air and soil quality, optimising flows in healthcare services, transport flows, etc. • Systems administrators trained in hardware impact & resilience • Digitisation/ Automation with a view to dematerialisation • Transformation of business models to take account of the analogue: resilience, proximity, circular economy • Intelligent Energy Systems Architect • Analyst of solutions for steering the company's sustainability programme
Germany	In the long run, German experts discuss the impact of EU regulations, e.g. DPP (Digital Product Passport) on digital sustainability jobs. Compliance will become an important topic. Relevant roles will combine IT and management. One expert foresees that all three roles' categories (management, data processing and development) will probably be equally important in the long run, while another expects roles related to data processing and analysis and development will be the most needed and crucial roles in the future. Another thinks that roles is in both management/ consultancy and data development/ analysis will be in demand most. Overall, roles in all three categories will be needed. The experts agree that there will be more standardised digital sustainability roles and that IT is going to be used as a vehicle to achieve sustainability, with a large demand for consultancy roles, together with data analysis.
Hungary	According to Hungarian experts, the demand for digital sustainability roles is expected to remain high and will continue to grow in the long term. Experts foresee that organisations will increasingly recognise the importance of sustainability in their operations and sustainability will be integrated into all business functions in the long run. In particular, they mention **digital sustainability leads** and **managers** and add skills to particular existing roles, like developers and data scientists. It is also pointed out that the long-term demand will likely depend on the **demonstrated benefits** of digital sustainability in driving business improvements and competitiveness. This means that digital sustainability roles could become more embedded within corporate structures if these roles prove their value in efficiency and cost-effectiveness and businesses realise the long-term benefits. However, the **persistence of these roles** will require **continuous adaptation** and **commitment from leadership**.
Ireland	The Irish experts expect that sustainability in relation to descriptions of job vacancies in ICT will become more prevalent; they foresee specifically a substantial increase in the demand for **ICT sustainable software developers/administrators/architects**. Also, that companies will be able to attract talented employees by showing they value sustainability, CSR, etc. as there is an emerging trend amongst those entering the workforce for the first time on the alignment of the organisation's culture and values to their own personal requirements.
Italy	Italian experts expect new roles integrating digital and sustainable skills to emerge over the next five years. These will include **environmental data analysis specialists**, **sustainability consultants**, and **green project managers**. As the demand for these roles grows, companies will need to adapt their hiring and training strategies accordingly. Then, the discussion in Italy focused on skills and education. These aspects will be addressed in those sections.
Nether-lands	Dutch experts state that there may be a need for a new C-Level role, a **Chief of Execution (CoE)** someone who oversees transformation and cross-departmental or even cross-organisational alignment changes, this may include overseeing the redesign of business processes.

	There will be a growing importance of understanding what data is needed for twin transition in ecosystems, so a new field will be the 'economics of data sharing' in five years' time. The experts also expect new roles to arise as not all skills can fit into existing job roles that still need to be carried out.
Romania	Romanian experts do not comment on many specific roles that will be important in digital sustainability in the longer term. However, they do expect that there will be a decent demand for digital sustainability functions. They mention a s**ustainability officer** and **a sustainability champion**; an 'agent of change,' someone who specialises in internal communication and can effectively spread the message about sustainability. They also indicate that sustainability is an important issue for young people. Experts stressed the importance of education and training. These aspects will be addressed in that section. For now, the expectation is that the next two years will mark a period of change for many companies, which will adapt their processes and adopt artificial intelligence technologies. The demand for digital sustainability functions will only become apparent after these years.
Slovenia	In Slovenia, the experts see an explicit need for a **digital sustainability consultant;** someone who will work in ICT companies and in non-ICT companies alike.
Spain	Spanish experts foresee an explosion in demand for more specific profiles and roles in sustainability in ICT. This is especially driven by regulations, such as the digital product passport. However, it is difficult to predict exactly under the uncertain conditions related to developments in IT, such as AI. The one role they mention is a **leader in sustainability in ICT.** Furthermore, they consider regulation the first step towards a much more encompassing movement at a global scale towards sustainability.

7.5.3 Summary of national panels on current skills needs

Belgium	In the short term, **reporting skills** will be in demand, according to Belgian experts. Those with reporting skills who prepare the reports are best combining these skills with the skills of a sustainability solutions designer or sustainability software developer, as they need to understand what to report on and how. While understanding regulations and the big picture is necessary, it is not necessary to have a thorough knowledge of the law. They can get legal assistance for that. Legal profiles will thus be needed in support roles to ensure compliance with EU directives. In addition to these skills, **eco-design and green coding skills** are also needed to build IT systems efficiently. This relates to technical specialists in the field of sustainability. Data collection skills are also needed, especially when it comes to **smart, ethical and inclusive data collection** to reduce biased information. Furthermore, experts see a need for **basic management skills**, a **multidisciplinary mindset** and **soft skills** in general for any role in sustainability. Two other personal traits are highlighted: **empathy**, as opposed to selfishness that does not go hand in hand with pursuing climate goals and **awareness**, in the sense of **understanding their impact on sustainability** and the principles behind it. Besides, knowledge

	of **sustainable IT**, to **produce systems that are optimised** with respect to both environmental and business concerns will be needed for sustainable data architects. The internal lead or external consultant must be skilled in **producing the strategy and governance.**
Bulgaria	Bulgarian experts note that the role of the IT professional is evolving and that several specific skills are needed in the light of sustainability. They consider the role of the IT professional essential in driving sustainability efforts and place it at the centre of the action, implementing **cross-functional teamwork**. In the short term, IT/digital specialists need to follow the sustainability trend and keep up to date with the **IT sector's carbon footprint**. They should be able to **assess their own company's digital footprint** so that in the longer term they can develop strategies and **contribute to carbon reduction plans**. Key roles in digital sustainability are expected to emerge during this process. They elaborate on sustainability-related skills, which they consider relevant for all IT/digital specialists. They mention specific skills: **expertise in data analysis, visualisation and effective project management** to make informed sustainability decisions and successfully implement initiatives; a thorough **understanding of environmental regulations**, crucial to ensure that digital solutions comply with legal standards and reinforce sustainability credentials; an **understanding of the impact of climate change** with cause-and-effect relationships; and **familiarity with sustainable practices**, such as **life-cycle analysis and circular economy models,** to **incorporate environmentally friendly approaches into digital solutions.** Sustainability software developers and engineers should master the following key technical skills: **IoT technologies, programming languages (e.g. Python, Java, C++), cloud platforms (e.g. AWS, Azure), Edge/Fog Computing, data analytics and AR/VR development.** Strong **communication and collaboration skills** are considered essential for engaging stakeholders and achieving sustainability goals. IT specialists must also have **innovation and problem-solving skills** to tackle complex sustainability challenges with creative solutions. All IT specialists need **anticipatory skills** to **introduce and manage carbon-neutral systems** within their organisations.
Croatia	All Croatian experts stress the importance of sustainability, including digital sustainability skills. Due to fast changes, they find it difficult to divide them into skills needed in the short term and skills needed in the longer term. In general, experts see two phases in the digital sustainability transformation: For the next two years, it is necessary **to make people aware of their actions and how they can contribute to sustainability** and a sustainable business, and also how digital skills can support that. After that, **new skills can be developed and existing skills improved** for the long term. They call on education to develop skills for sustainability, in order to develop a workforce that acts accordingly. In particular, they stress the importance of a skillset related to **a holistic and interdisciplinary design** approach.
Estonia	In their discussion, the Estonian experts highlight three main areas that are crucial for advancing digital sustainability in the coming years. First, they consider **the ability to design,**

	implement, and manage energy-efficient IT infrastructures, such as servers and data centers, a critical skill. This enables organizations to reduce energy consumption while maintaining high performance. Second, **the ability to develop software that is energy-efficient and minimises environmental impact** throughout its lifecycle emerged, a key focus. Finally, they emphasise the importance of **data analysis skills to make informed decisions** that improve sustainability outcomes.
France	French experts agree that a combination of skills and an overall vision and approach are needed to successfully implement digital sustainability projects. They see a need for **interdisciplinary/ multidisciplinary profiles** in digital sustainability, with skills in **general management** alongside **skills in different areas, e.g. marketing, communication and innovation**, in order to have a more global vision of different perspectives. Roles should also **combine skills** in different categories, such as **technical skills, strategic skills and intercultural skills**. Experts argue that managers should have some level of knowledge of technology, **understand how technology can be used** and have the **ability to develop sustainable solutions**. A combination of skills in an interdisciplinary/ multidisciplinary role is thus needed to manage this type of project and have a global vision. System administrators or the person responsible for process automation should have **skills related to environmental viewpoint**. Experts distinguish two phases: In the next 2 years, engineers are needed with skills related to the **planning part of sustainability projects, resulting in a strategy.** After this phase, operational skills are needed for implementation. This includes a project manager who **understands the plan and its purpose**. They point out the importance of an even broader perspective: The **whole value chain** must have tight processes to avoid waste. Agile ways of working automatically support sustainability. Also, **users/customers** should not be forgotten in these processes and **should be trained** to use these solutions. This means **communication skills** are also very important. Besides, someone with an **understanding of regulations and legal aspects** in the area of digital sustainability is also needed. When it comes to technical skills, those r**elated to smart cities** will be needed, like **IOT, sensor networks, quality measurement, water, air and soil quality.** Likewise, also the ability to **manipulate massive amounts of heterogeneous data**. An **understanding of the tools or solutions to make smart cities more sustainable**, will be needed for people in public procurement**.** Skills in **eco-design** and **electrical and electronic equipment waste** are also important in relation to managing the end of life of equipment. **BOARD NOTES:** • General Management • Data Analysis and Big Data • Marketing and Communications • Coding, software development, machine learning • Environmental Management • Statistical analysis of massive data • Carbon assessment + understanding how to measure the main environmental impacts • Value chain analysis • Measurement, analysis and reporting • Communication and awareness-raising • Compliance: CSRD, EMAS, ISO 14001, etc. • Lack of understanding of the impact of digital technology: Negative impact little or not understood + Positive impact almost never exploited • IoT • Lack of understanding of the term sustainability. Most often equated with environmental protection. However,

	there are big social themes, big resilience themes, big economic themes, in particular sharing, cloud... • Eco-design of digital products/services • Treatment of WEEE • Circular economy • Carbon measurement • Responsible design of digital services (including AI) • Knowledge of environmental policies and regulations • Training and awareness • e-accessibility • Environmental management control • Economic and legal risk in ecological transition • Global risk analyst • Transposition of CSR risks into banking and insurance risks
Germany	When it comes to needed skills in the short term, German experts see a need for skills related to **regulatory frameworks, data analysis, ESG reporting** One expert observes that there are many skills worth considering, like **team management** and **data analysis**; but very crucial are skills related to **change management**. Other experts also point out the importance of change management, in particular together with **communication**. These skills are needed skills to engage employees towards sustainable behaviour and to weave these practices in the corporate culture. There must be a flexible culture and an awareness of cultural differences. German experts agree on the importance of **critical thinking** and **innovation**. They observe that currently, the focus is too much on the ecological and societal perspectives, and more work should be done to support and investigate the economic side of sustainability. Digital literacy was mentioned as a prerequisite. It is stated that it is crucial for a sustainability manager to have some technical competence, such as data analysis. Strategic decisions and how they are taken and improved are also important especially in relationship with product adaption and design. Considering a data-oriented approach to designing and creating a sustainable secular product is also important. Using AI in data analysis and processing is important. Being able to deal with **data and tools from different providers** and understand how they operate is also a crucial skill.
Hungary	For Hungarian experts, the skills required depend on the specific sustainability role. **Understanding CSR policies, ESG reporting, laws and regulations** are important for digital sustainability leaders and managers. For developers, the legal background is less important. They should focus on **energy-efficient technologies and ECO design**. Experts argue that **understanding sustainability frameworks** is important for all roles. The same goes for essential **soft skills, such as the ability to learn, strategic thinking, horizontal vision, adaptability, credibility and personal commitment**. Experts explain that having a horizontal vision, that is being able to **think horizontally,** means constantly relating one's actions to the company's overall strategic framework. A person skilled to **implement this at managerial level** will be needed and someone who can **communicate sustainability** properly to the members of the organisation, both to the employees and to the decision makers. Business analysts must **understand the sustainability process or reporting process** and have **insight in the sustainability tools and solutions** and how these could be implemented. To introduce sustainability changes in a company, **data needs to be monitored and analysed continuously**, so skills related to **data science** are needed. **Optimising code and infrastructure** to reduce energy usage and developing energy-efficient software is a skill for sustainability software developers. One expert points out that there will be a shift in the focus from purely technical skills to a broader understanding of sustainability as a **set of values**. The emphasis will be on how well

	professionals can **integrate sustainability into their daily practices**. For instance, roles such as data scientists will need to reassess their existing processes and make changes that align with sustainability goals. The challenge is not just acquiring knowledge but effectively applying it to achieve these goals. Every skill set required for these roles will need to include elements that **ensure the achievement of sustainability goals**. This indicates a shift towards a more **holistic approach** where sustainability is **not just an add-on** but an **integral part** of the decision-making process in various roles.
Ireland	All the Irish experts agree that **multidisciplinary and transversal skills and mindsets** will be a priority. They also expect a rising demand for the use of technology in a more climate/sustainable friendly way and this is where **sustainable software and sustainable ICT skills** are required. Appropiate use increases the lifetime of hardware, leading to cost reductions. Also, new **sustainable software coding skills** are required; a better understanding on **how code interacts with infrastructure, end users and telco**. Experts foresee a massive demand for **ICT/digital skills to support the decarbonisation of the energy and transport sectors**, related to the intensifying application of heavy metals for green purposes, like EV cars and wind turbines.
Italy	In Italy, experts stress that the digital and sustainability transition is a crucial challenge for European companies, especially SMEs, which need to adapt to this changing market. They stress the **need for a strategic approach to support companies, from SMEs to large enterprises**, in achieving sustainability and digitalisation goals. Experts agree that developing a new strategy to build the necessary skills for the labour market is crucial, as current gaps need to be addressed. They expect traditional IT roles to evolve and include sustainability competencies, such as **energy-efficient computing** or **sustainable data center management,** with professionals that are not only adept to using digital technologies but also having **a deep understanding of environmental and social impacts.** There will be a need for professionals who are skilled in **utilising digital tools to meet sustainability goals,** including leveraging **data analytics** to track and reduce environmental impacts**,** implementing **digital solutions for sustainable supply chain management** and **utilizing technology to enhance energy efficiency.** The discussion is moving towards training the existing workforce. These points are addressed in that particular section.
Nether-lands	Among Dutch experts, the debate focuses on the question of who exactly should have digital sustainability skills. Does everyone need all twin transition skills, or does it depend on the role? And should there be so-called 'boundary spanners' in every department? People in these latter roles need to be able to **collaborate in a multidisciplinary way**. Experts point out that behavioural competences are easily overlooked; **situational awareness** and **understanding interdependencies** are important. **Collaboration, communication, sensitivity and organisational awareness** are also mentioned.
Romania	Romanian experts argue that companies should focus on **effective leadership** and **fostering positive attitudes** to enable a smooth transition to digital sustainability. According to them, **data analysis, data management, data collection and data validation** will be essential skills for all specialists in the near future. They also foresee that every company

	should have a specialist with **legal expertise**. They mention the importance of **considering human aspects**, such as employee well-being. They also stress that the **ability to unlearn** is equally important; employees will have to perform different tasks than they are used to.
Slovenia	In Slovenia, the experts stress that sustainability is a **very broad topic** and also includes, for example, **personal health and well-being in the workplace**. They then elaborate on the importance of **understanding ESG and acting on it**, including issues such as **circular economy, environmental, social and economic impact, the importance of the value chain, circular systems, acting on legislation related to electronic waste management and striving to maximise waste recycling.** Skills related to **ESG reporting** would be needed for sustainability managers. They also mention having knowledge of **good sustainability practices** in the sector; rejecting projects that encourage waste (e.g. developing software to increase sales of single-use plastic products) and creating digital content in a way that does not exploit the psychological weaknesses of the public (e.g. creating dependency, FOMO effect, etc.).
Spain	All Spanish experts agree on the fact that the urgent skills needed in the short term are the more transversal skills, especially related to: **team management, the regulatory framework, data analytics, effective communication, change management, project management (including management of uncertainty and risks), critical thinking and innovation, engagement and taking responsibility** and **the capacity to measure and valorise impact**.

7.5.4 Summary of national panels on future skills needs

Belgium	As for the longer-term situation, Belgian experts point to the desirability of finding common ground between industry on the one hand and environmental scientists on the other. Both categories must understand each other and not continue to work side by side in silos. Thus, the business people need to be trained in sustainability concepts (rebound effects, impact transfers, carbon accounting and scopes, carbon neutrality, etc.), while the environmental scientists need to understand the current state of business and how to move to circular/sustainable business models, based on data collected and expertise gained over the past 5 years of reporting. After the reporting phase, it is important to actually take action, this is linked to **accountability**: management needs a**n overall view of the impact** and needs to know **how and where to act** to reduce the environmental impact of their IT infrastructure. To get implementation right, different departments need to work together to implement sustainability principles. There is a risk that sustainability becomes the goal of only the sustainability team. **Collaboration** is therefore another important skill: not working in silos and aligning goals of different business teams. Other soft skills needed are: **communication** and an **intergenerational exchange of knowledge** (collective intelligence).
Bulgaria	As legislation increasingly requires companies to provide sustainability data, Bulgarian experts expect demand for key sustainability skills to increase: **life-cycle assessment, circular economy**

	principles and **advanced sustainability reporting**. This will coincide with a demand for skills in **AI and machine learning** for sustainability software developers, as this is crucial for improving **predictive analytics** and enabling **automated decision-making in sustainability** efforts. Other skills mentioned by the experts include: **effective leadership** and **change management**; essential for successfully managing sustainability transitions within organisations, **continuous learning** and **adaptability**; necessary for keeping up with changing sustainability challenges and **understanding incentives and consumer behavior**; valuable for **evaluating the impact** of digital sustainability solutions. The experts consider sustainability a transversal skill, that should be integrated into all roles and processes within organisations. It is essential to make sustainability practices a core part of the company culture, especially in SME's where adding employees is challenging.
Croatia	Croatian experts tend towards an evolutionary approach - as society and individuals evolve with their awareness, so will the demand for different skills. Specific skills mentioned are **basics of ESG; green IT practices; assessment of efficiency, cost, and sustainability; delivery of products within green IT practices** and **data monitoring**. There will be an increasing need for **analysing the comparative advantages** of sustainable solutions.
Estonia	Estonian experts find this **difficult to predict for the long term**. However, they do expect that digital sustainability professionals in all roles will need **strong soft skills**, particularly in **leadership, communication,** and **collaboration**, **to drive sustainability initiatives effectively** across different levels of the organization. Besides that, they expect **managers** to **enforce and monitor sustainability best practices** ensuring that **sustainability is embedded in the company culture and operations.**
France	For the longer term, French experts see different needs. There will be a need to develop skills in **sustainable digital procurement**, as the environmental and social impacts of digitalisation stem from the supply chain and production and are therefore closely linked to procurement management. Experts discuss the concept of the **regenerative economy** and its feasibility. They see a shift from carbon measurement alone to **a much more global measurement with changing impact factors**. There will be a need for people who can take those impact factors into account and who **know and apply methods, tools, input data and perimeters to make global measurements.** Knowledge of the tools, methods and associated perimeters is required. Experts agree and see an increasing need for **impact measurement and further professionalisation of this field**, probably even within the next 2 years. This **understanding of impact factors** relates to the supply of materials and equipment according to the geopolitical situation with a greater awareness of the analogue infrastructure behind the digital level leading to a change of focus and of business models. They also point out that it will be necessary to develop **digital solutions that will have a net positive impact on sustainability.** Currently, the focus is too much on reducing the carbon footprint and not on

	developing solutions that have a positive impact. There will be **a trend towards an industrialization of data management** and this will lead to more sustainability programs and action plans. Many different roles and skills will be needed to implement and maintain the digital sustainability solutions being developed today. For example, in a smart building equipped with sensors and an AI system, roles and skills will be needed around sensor manufacturing, IoT, maintenance assessment and actual recalibration of sensors, etc. **BOARD NOTES:** • Sustainable IT Project Management, Sustainable Change Management • Global measurement: eq. CO2, GHG, Resources (minerals, water...), Pollution • Raising awareness among operators / implementers • Interdisciplinary profiles • Knowledge of ESG investment criteria • Biotechnologies and Innovative Materials • Automated Environmental Management Systems • Responsible purchasing
Germany	In the long term, German experts consider it important that employers and employees have the openness to **adopt and learn new technologies**, like 5G, blockchain and IoT. Some experts foresee that thse technical skills will be important in the long run. Another expert points out that skills needed depend on the job domain. Also, **soft skills, critical thinking** and **change management** are skills needed in the long run. In particular, **thematic thinking** is mentioned; as opposed to one-sided or narrow-sighted thinking; keeping an eye on **the bigger picture and strategic goals**. Other skills were discussed as well, such as **management, value-oriented leadership** and **communication**.
Hungary	As sustainability will increasingly become an integral part of organisations' strategies and operations, Hungarian experts foresee an equally increasing importance of sustainability skills. For executive positions, such as **digital sustainability leaders and managers**, a **thorough understanding of emerging sustainability trends** and **the changing regulatory landscape** is essential. For **developers**, the long-term focus will shift to **mastering advanced energy-efficient technologies** and **integrating sustainability into the software development lifecycle.** Knowledge of **circular economy principles** and the **ability to design for sustainability from the ground up** are expected to become crucial. For developers, it will be essential to be **up to date with advanced energy-efficient technologies and methodologies** to continuously improve the environmental performance of digital solutions. Soft skills mentioned are **visionary thinking, strategic foresight** and **adaptability**. Overall, companies will need to cultivate **cross-functional competencies**, ensuring **managers** are knowledgeable and up to date about **sustainability practices**, starting from **consultancy** and **gradually building these capabilities internally**. There will be the necessity for **personal commitment** to sustainability, extending beyond leadership to include every employee. The focus will be on ensuring that sustainability is genuinely **embedded into the organisational culture**. A prerequisite is that the company's sustainability measures are connected to either profit enhancement or cost reduction, otherwise the strategy will never truly be effective.

	Therefore, in the future for a **business leader**, the focus should be on **leveraging sustainability to gain a competitive advantage,** aligning sustainability efforts with the company's broader business goals**.**
Ireland	Irish experts anticipate a substantial increase in **demand for skills related to ICT sustainability, resource aware computing,** and for **digital skills in green marketing, circular economy, sustainable finance** amongst others. **Multidisciplinary** and **transversal skills and mindsets** will be a priority. They expect job descriptions for the new generation of ICT professionals will encompass both green and sustainability phraseology in the adverts. They also foresee that sensible companies will **change their ICT procurement** requirements to buy only from recognised organisations who have a **'sustainable first'** digital model. It is stated that EU regulation will dictate the skills required.
Italy	Italian experts point out that the transition to a more sustainable and digital economy is an evolving process that requires **constant adaptation** of workplace skills. Experts agree that **sustainability and digitalisation** are not separate goals, but rather interconnected challenges that companies need to **address holistically.** There will be a need to combine skills like data analysis and programming with an **understanding of sustainability principles and practices**, like **circular economy models, renewable energy technologies, and sustainable product design.** Besides, professionals must understand the **ethical implications** of their work and act on that. This includes understanding issues such as **data privacy, algorithmic bias**, and the **environmental impact of digital infrastructure.** Experts note that there is a trend to stop seeing sustainability as pure marketing and that sustainability should be approached from a technical and quantitative mindset rather than purely as a marketing strategy. This means that professionals need to be able to **use data and metrics** to measure the impact of their actions and make informed decisions. Experts consider this crucial for the long-term success of digital sustainability initiatives. The experts emphasise **change management and leadership skills**, as digital sustainability initiatives often involve significant organizational transformation. They consider effective leadership crucial for **driving change** and **fostering a culture** that values sustainability across all organisational levels.
Nether-lands	An u**nderstanding what data is needed** for twin transition in ecosystems will be important and the experts point out that the **economics of data sharing** will be a new field in five years' time. There were no other skills reported for the long term; it is reported that the discussion focused on roles.
Romania	Romanian experts note in general that companies need to adjust their business models to stay in line with the market. Asked about long-term digital sustainability skills, experts find **communication and storytelling** crucial to convince employees to engage in new sustainability roles. These can be skills for a **sustainability champion**. **Sustainability managers** need to explain the benefits of sustainability to each individual. **Adaptability and high tolerance** are also

	considered important skills in the digital sustainability sector, as this field is not always of interest to all customers. **Understanding the market and risk analysis** are essential to be prepared for change. Sustainability officers must have expertise in **environmental issues** in addition to know-how in **data management**. Other skills mentioned include **teamwork**, for acquiring digital sustainability competences; **innovation and creativity,** needed to **develop better cost-effective actions, optimisation processes and cost-saving strategies**; and **curiosity**, which helps employees stay anchored in changing realities. It is also pointed out that corporate culture should **support humanity** as part of the broader strategy.
Slovenia	Slovenian experts found this difficult to predict for the long term, so no skills were reported.
Spain	In the long term, Spanish experts agree on the need for **strong management and value-oriented leadership skills** with **social engagement**. Soft skills are important, mentioned are **communication and critical thinking, flexibility, adaptability to change, management of sustainability projects, systemic vision of the organisation, dissemination and transfer of results, knowledge of the regulatory framework and all related updates. Teamwork** is considered very important, with related aspects: **tolerance for mistakes, adaptability to change and empathy. Privacy and risk management** are also mentioned. Combined with technical knowledge, such as **5g, blockchain, GenAI and data, big data analytics.** Regarding sustainability skills/competencies, experts mention the **circular economy** and **strategic innovation,** especially new forms of data integration to support sustainability. **Knowledge of EU funding** related to digitalisation and sustainability is also considered important. Experts agree that other regulations for **social sustainability,** such as **digital accessibility,** should not be overlooked.

7.5.5 Summary of national panels on current education & training needs

Belgium	First, the Belgian experts note that sustainability is given little or no attention in traditional education. They call for **academic awareness/sensitivity** about these topics and for sustainability to be **integrated into traditional training courses**. It should be a **holistic approach**, **not a simple add-on**. This has to do with the idea that everything is interconnected; and this is especially true when it comes to sustainability. Trainings should also have a **multidisciplinary approach** to bridge different disciplines. The experts also indicate that there is a need for **tailored training** in digital sustainability for specific, already existing roles, especially **managers and HR executives**, to get these people involved in the topic and explain what it means specifically for them. They also mention trainings

	for **data engineers** and other **IT professionals** to explain best practices in digital sustainability. **Sustainability data architects** will need to have a high level of knowledge in sustainable IT.
Bulgaria	Bulgarian experts note a **low current coverage of digital sustainability in educational programs**. They highlight a clear gap in formal education for digital sustainability roles. Therefore, **re- and upskilling the existing workforce** through **short-term courses and certifications** is currently more practical than establishing dedicated academic programs. Educational institutions may gradually incorporate these topics into their curricula as demand grows. There are new STEM centres in Bulgaria that are focused on green energy and sustainable technologies. These offer significant opportunities for developing training content and resources. However, educators may need additional support to maximise this potential. In the experts' opinion, **all employees should receive basic training in sustainability and climate change** to build a culture of sustainability within organisations. **Continuous development of sustainable digital skills among employees** will be necessary for effective implementation. This training could be delivered by a **dedicated internal trainer** or **through shared roles across departments**. They distinguish different **types of trainings**: Ones that are intended to **raise awareness** (typically very brief); Ones that provide the **fundamentals** (cf. the so-called '101 trainings'); **Advanced trainings for experienced professionals**. For example, existing software developers and engineers can be trained on sustainability issues to leverage their technical skills to integrate sustainability. These professionals already possess the necessary technical skills, and with appropriate education, they can effectively integrate sustainability into their work. In the first couple of years, demand will most likely be low for advanced trainings. After more years and if interest in the field is still strong, it can be expected to see a rise in the demand for advanced trainings. The experts also list **key skills that should be incorporated** into training programmes: **understanding environmental regulations, sustainability reporting,** and the use of **advanced technologies** such as **AI, IoT,** and **AR/VR**. Courses and certification preparation in **IoT, Cloud Computing**, and **Edge/Fog Computing** are essential for **sustainability software developers and engineers.** And also training in **AR/VR** is particularly valuable for them, as it enables them to design innovative simulations and interactive tools that effectively demonstrate and integrate sustainability practices. It is even argued that these trainings **should be available not only in universities but also in schools** and other educational institutions to equip developers with the skills needed for advanced, sustainable technology solutions. One of the experts states that it is unlikely that dedicated programmes/ training tracks for the field (e.g. a dedicated Digital Sustainability MSc or BSc program, etc.) will be implemented, unless the job market offers a significant number of such positions and this demand is clearly visible to potential candidates. If these programmes are nevertheless created, it could be questioned how successful they will be. At this stage, this means that it probably makes more

	sense to **introduce separate trainings**, e.g. an **elective course as part of a BSc programme**, **short-term trainings as part of a track at an IT academy**, etc. These trainings will be better positioned at educational institutions that are already providing the required foundation, where they can complement the existing programs. For example, a digital sustainability data analyst has to draw on a list of data analysis competencies, which are not specific just to this area; but are the same for finance, healthcare, etc. Experts agree that the current low coverage of digital sustainability in educational programs and the **need for incremental training and awareness-raising activities** are significant challenges. They consider (1) **building strong industry-educational partnerships**, covering universities, schools and academies, (2) **identifying and involving experts** (who are already working in the field and have gathered enough experience, knowledge, contacts, etc. and are both willing and able to pass that to others), (3) **creating practical training resources and courses** essential steps for developing effective programmes, and (4) **performing at least one iteration of such courses** at all institutions. The contributions from the experts involved in this process under step (2) may take different forms. For example, course design, design of training resources, carrying out trainings, 'train the trainers', forming and sustaining a community of practice, taking the role of an evangelist for the field, etc. Open courseware may be developed on a "by the IT sector, for the IT sector" principle. The experts conclude with stating that the success of sustainability initiatives depends on **senior management support,** but also on **support for educational institutions** to develop proper training resources. They will need clearly defined requirements and professionals capable of designing the materials and teaching them. **Mentoring** will also be very important.
Croatia	Croatian experts agree on the need for **investing in education and reform curricula**. **For the short-term, the focus should be on the current workforce.** Using **microqualifications and certifications,** the existing workforce can be requalified, to reduce the gap between existing knowledge and skills and market needs. **Vouchers** may be used for this requalification. In Croatia, with the support of the European Union, there are vouchers for requalification that can be used for private and public educational institutions, and there are also programs available to better navigate the digital and green transition. Digital sustainability must be part of education programmes, because students who go to school today are the ones who will be in the labour market in the next 2-5 years. Much is already being done and implemented in curricula, but education needs to start **as early as kindergarten** to be on the path to sustainability. From the beginning of education, it is necessary to develop skills for sustainability - then we have people thinking, planning and so on.

	In the next two years, we need to **make people aware** of what they are doing and how that contributes to sustainability and sustainable business, and how digital skills can help. Then develop new skills and upgrade existing ones for the long term.
Estonia	Estonian experts highlight the importance of providing **short, targeted training programmes** that can quickly upskill the **current workforce**. These programmes should focus on **integrating sustainability into existing roles**, to equip professionals with the skills they need to incorporate sustainability into their day-to-day responsibilities.
France	In France, the experts discuss the effectiveness of adding courses to a curriculum versus a situation where sustainability is an integrated part of the full curriculum. Some experts feel that **micro-credentials** can be a way to offer practical, specialised training in an attractive, flexible and more tailored way. They can be used in addition to a professional master education. Companies criticise this type of education because it is often too specialised and students lack more general knowledge making them less able to adapt to different situations. A balance needs to be found for the master programme. **A combination of more general master courses supplemented by specific short training courses** that will specialise students could be the solution. Other experts do not think that adding a few short, specialised training courses after a study can really make a difference and advocate **integrating sustainability into the full curriculum** of the general IT bachelor/master. For the longer term, experts express their hopes for a switch from the current approach of training people in IT and making them aware of environmental issues towards **a reversed situation of explaining how IT works to use it as a tool for a positive and lasting impact**. For HE this means that in designing a Bachelor's or Master's degree, one must start with the ESG dimension, introducing IT as a tool instead of the other way around. The government can support this by explicitly including ESG requirements in tenders. This may inspire to incorporate ESG considerations in training courses. In France, there are already regulations requiring universities to include sustainability in their curricula. This sometimes leads to artificial situations; not to every subject is sustainability relevant and or directly applicable. Experts agree that **raising awareness and starting a dialogue** is good (see climate fresk), but that there should be a **follow-up on the practical implications in the workplace**. So, to go further, **MOOCs, trainers or independent consultants** can be used, to train people more precisely on different skills and professions. Then, a certification or labeling system could validate these skills and display this validation. People in **public procurement** should be trained to understand what tools or solutions they need to buy to make their city more sustainable. It is also expected that **SME's** will partly use external consultants and partly need to train their own staff. Experts stressed the importance of training digital sustainability skills in people in existing roles, e.g. the **system admin. Users** must

	also be trained in the use of these solutions. This implies that communication skills for change managers are important.
Germany	When it comes to the need for training and education in the short term, German experts observe a large need for **general training** on digital sustainability and addressing **management executives** with **more specific training** schemes. Besides, also a need for **specific upskilling training with an individualised approach** (related to different skills levels of employees) is mentioned. Training sustainability skills should be focused on people who already have their own capabilities or skills in place, like technical skills. On the other hand, there is a need for **collective training** to a group of or all employees in a company on general skills such as acquiring technical privacy/ security skills that can support sustainability. **Microcredentials** must be integrated in the upskilling strategy of a company. One expert argues that training in this field should become a legal requirement. (Like IT training, which has been mandatory in Germany since 1987 for all students in vocational education and training, regardless of their field of study.)
Hungary	In Hungary, the experts agree that sustainability must be included in university courses, to ensure that it is incorporated in future jobs. In the long-term experts envision an ideal situation where sustainability is **embedded as much as possible in entire curricula across all subjects**, fostering a horizontal sustainability mindset. For some roles, the experts think that **general sustainability education** may suffice, like a sustainability data scientist. People working in this role need to understand the basics, due to complex measurements, flexible rules etc. They expect a **growing need for dedicated, more in-depth training** for professionals working in specialised fields such as energy efficiency, waste management, and social sustainability. Training should be **practical and focused on immediate benefits**. There is a need to shift from general to specific training that can later be generalized - starting with specific, actionable points that can be directly implemented, ensuring that learners can immediately apply sustainability principles in their respective environments. For example, programming education should introduce students to sustainable technologies right from the beginning, ensuring that they are not just learning Java, but learning it with sustainability in mind. Moreover, to bring about meaningful change, **education must foster continuous focus** through **campaigns, discussions and debates**, rather than merely offering sporadic training sessions.
Ireland	Irish experts agree that there are very little upskilling options available today in Ireland so **existing courses be they levels 5-8 could have sustainability modules included** or **existing modules remodelled to include a more sustainable focus** in a given module. For example, it would be easy to add a sustainable cloud learning outcome to a module on cloud computing without creating a new course/module. Additionally, experts express the need for **creating upskilling possibilities**, like **short, industry certified courses, micro-credentials,** and **CPD**. All team leads, unit managers, senior managers/directors will need these short CPD/micro-

	credentials on sustainability. They suggest **short upskiling masterclasses** with access to **case studies of best practices** that could be **supported by skills pathways/ courses** for decision makers. The experts consider C-Suite training critical as they need to understand national and international sustainability policies and goals and the finance required to execute those requirements internally. Also, an organisation typically with a facilities manager or smaller companies with an operational manager, will anticipate immediate training needs for these individuals and potentially, likewise for a CTO. The courses these people will follow will focus on **sustainable IT** and mainly the **hardware**. They stress the fact that educating must start already with primary/secondary school students.
Italy	The Italian experts observe that the current education and training systems are not fully equipped to produce graduates who meet the changing market demands related to digital sustainability. They agree on the fact that that **traditional educational models must evolve** to include **interdisciplinary curricula that blend technology, environmental science, and business strategy**. They discuss the balance between theoretical knowledge and practical skills. Some experts argue that current educational programmes are overly focused on theory, neglecting the hands-on experience necessary to implement sustainable digital solutions effectively. The importance of **integrating real-world applications and case studies into educational programmes** is highlighted to provide students with a comprehensive understanding of **how digital tools can be applied to sustainability challenges.** The debate also highlighted the necessity for **continuous learning and professional development**, as digital technologies and sustainability practices evolve, professionals must regularly update their skills. Participants agree on the importance of upskilling existing workers rather than hiring new employees, as it allows companies to build on their existing knowledge and experience. There is a shared belief that training should focus on **key areas** such as **data analytics, systems thinking, and sustainable design principles**, equipping professionals with the tools needed. Upskilling and reskilling initiatives of the current workforce are considered particularly important in the **field of data analysis, sustainability consultancy and operational management.** Experts also stress the necessity of a **collaborative effort between academia, industry, and government/ policymakers**. They expect partnerships with industry leaders could provide valuable insights into the skills and knowledge that are most in demand, ensuring that educational offerings align with the needs of the job market. **Government support** is also deemed crucial in establishing incentives for businesses and educational institutions to invest in sustainability education and training initiatives. Overall, **fostering a mindset that values ethical considerations in technology deployment** is crucial. This ensures that digital advancements align with sustainable development goals.

Nether-lands	In the Netherlands, the experts debate on the need for upskilling with regard to competences, or raising awareness on all aspects of sustainability that are linked to digitalisation. It is also suggested that it is better to train managers to formulate sustainability related quests to data analysts, than training the analysts themselves. They will perform the query provided to them.
Romania	In Romania, the academic panel experts highlight how **universities can create synergies with public and private entities to develop better training programs** for preparing future specialists. They point out that universities have a significant role in supporting professional reconversion. In their opinion, **universities, industry and the private sector need to collaborate**. Accelerated education in the field of sustainability should be a top priority in the coming years. This could begin by shaping employees' mentality towards openness, embracing digital change, and adapting to the new environment. They also mention the fact that Romanian companies already have expressed the **need for training in the field of sustainability**, particularly regarding **the formation of sustainability teams**. They think it is evident that in the coming years, there **needs to be more clarity around what sustainability entails and how it can be implemented**. Currently there is no standardised 'formula' for sustainability, and it remains unclear what it will look like in the future. A first step, and a good practice would be to **establish specific indicators to validate sustainability efforts.**
Slovenia	According to Slovenian experts, **micro-credentials** are essential in this field; this can be micro-credentials for a specific industry or interdisciplinary ones. In the short term, they see a need for **offering short trainings and certificates** to the employees of the company. They distinguish two types: one type of training focussing on **basic knowledge for all the employees** and one **depending on the role in the company**. They advise to start with small steps and have 5-6 trainings in 1 year. They point out the importance that **top management should be aware of the topic of sustainability** and supports training in this area. Besides knowledge of sustainability practices, also sector-specific knowledge is needed. This means that someone working in the sector could be upskilled on the part of sustainability, or someone outside the sector must acquire sector-specific knowledge.
Spain	Spanish experts report a need for **short, targeted training programmes** that can quickly upskill the current workforce. These programmes should focus on integrating sustainability into existing roles, that focus on practical skills and knowledge. They also see a need for **a general training on digital sustainability** addressing all the employees and **a more specific training for first level management**. Actually, all employees must be trained in **data and information management**. Higher education could develop **training programmes for leaders**. There are already some programmes on general sustainability themes. Besides these, they consider it important to **train specialised technical profiles** on sustainability, as well as to design **training for secondary**

	education. Experts stress the importance of '**train the trainer'** in particular to align programmes better with company needs and to close the gap between universities and companies, however teachers that can teach others are difficult to find. They consider it important that the training is **up to date**. This is easier with smaller units, like **micro-credentials**. These should be considered as it is adapted to the training needs within this field. The employees must be made aware that training helps in achieving the company business objectives. There should be **study plans** for workers and managers in the company.

7.5.6 Summary of national panels on future education & training needs

Belgium	In the long run, Belgian experts argue that **managerial roles** within companies should receive **tailored trainings**, e.g. **sustainable IT procurement workshops** for procurement teams. **Awareness of the supply chain (social and ethical aspects)** should be part of the training. They expect a need for **'niche masters'** that look at a specific topic from all possible perspectives; these are actually **dual-masters**, for example a master's in Eco-Design after a bachelor's in IT. Sustainability can be combined with any other expertise, such as a sustainable legal expert, sustainable IT architect, sustainable communications expert, etc. They also argue that the **basics for sustainability should be present in any education**. The experts consider **internships** within companies a must, as they are a win-win for both students and companies. Classic profiles will have to get trained to get up to speed with sustainability. They will need to understand a lot of concepts such as planetary limits, rebound effects, impact transfers, carbon accounting & scopes, carbon neutrality, globalisation, macroeconomics, etc.
Bulgaria	Bulgarian experts advocate the development of **standardised training for various functions,** such as **HR, procurement, C-level executives, key management and general employees**. This would streamline onboarding processes, customisation and development of products and services, and provide opportunities for collaboration across countries and industries, including the education sector and academia. In the long term, experts see the need for **sustainability software developers** to **remain flexible** and **adapt their training needs** to incorporate **new AI-driven solutions**. Besides training, there is also **a strong call for formal education pathways** and **comprehensive degree programmes in digital sustainability.** For the long term, the experts see an important role for education, to equip people who enter the job market as experts; the emphasis is placed on **secondary vocational education and tertiary education**. Experts point to the **importance of effective collaboration between companies and academic institutions**, although successful examples remain limited. They argue that it is important to include basic digital sustainability skills and principles into educational programmes from an early age, such as in secondary school. Given that active work has been done, experts expect to see an increased awareness of digital sustainability, a well-established community of practice and initial courses offered at universities and academies. Future plans may include the **development of dedicated BSc or**

	MSc programmes and advanced training options based on changing demand. **Continuous learning** and **adaptability** are necessary to keep up with evolving sustainability challenges.
Croatia	In the long term, Croatian experts expect education and training to **focus on creating new professionals,** both **through secondary education and higher education**. The experts outline the steps needed: • Invest in **practical experience** for future professionals • Establish **learning outcomes based on practical experience**, which should be **regularly adapted to changing circumstances** • Encourage **situational learning** • Monitor employees' adaptation to new situations through **mentoring** • Use courses such as: **Basic and advanced technical knowledge and skills; Fundamentals of ecology; EU policies and regulations; Energy efficiency; Waste management**
Estonia	Although Estonian experts feel that long-term training needs are difficult to predict, they stress the importance of **fostering a culture of continuous learning**. As sustainability challenges evolve, continuous education and training will be essential to retain a well-trained and skilled workforce.
France	In France, the experts discussed short- and long-term education and training needs in one. The information is included in the short-term overview. For the longer term, one of the experts expresses the **hope for a switch** from the current approach of training people in IT and making them aware of environmental issues towards **a reversed situation of explaining how IT works to use it as a tool for a positive and lasting impact**. For higher education this means that in designing a Bachelor's or Master's degree, one must start with the ESG dimension, introducing IT as a tool instead of the other way around.
Germany	In Germany, the main focus of the discussion is on how the need for training will move towards specialised roles that will support specific tasks in the long run. These roles are diverse, dependent on their different contexts. The experts also stress that **sustainability must be integrated into curricula,** to fulfill the demand for sustainability jobs. Regulatory pressure could support this, by bringing standardised and regulatory schemes and effectively apply them on the sustainability upskilling process. Overall behavioural skills must be improved in all employees, not just for sustainability specified roles.
Hungary	In the long term, Hungarian experts see the need to integrate sustainability education into **all levels of education and professional training.** This means not only **offering specialised sustainability courses,** but integrating sustainability principles into entire university curricula. This **holistic approach** will ensure that students from all disciplines develop a **sustainability mindset**, where sustainability is seen as the foundation of business thinking and consider **the environmental, social, and economic impacts** of their future professional activities. The challenge will be to ensure that all methodologies and practices are inherently sustainable, eliminating non-sustainable options from consideration. Education will need to **emphasise creating a culture** where sustainability is automatically integrated into decision-making processes, making it a standard expectation rather than an optional goal. This will require

	ongoing education and cultural shifts within organisations, supported by initiatives such as **communication campaigns** and **experiential learning**. In addition, they expect a growing demand for **specialised training programmes that provide in-depth knowledge in specific sustainability areas.** Staying updated with cutting-edge green technologies and methodologies will be vital.
Ireland	The Irish experts expect **a demand for reskilling and upskilling in specialised areas** in the long term. They mention the following key areas: Technical: **sustainable infrastructure design, sustainable application development, data management and analytics, cloud performance optimisation.** Business: **sustainable cloud computing strategies, new green business models in the cloud, cloud vendor management, green marketing, circular economy, sustainable finance** etc. In general, **existing courses should be updated** to include a new or a revised module on green computing.
Italy	In the long term, Italian experts expect a need for **continuous adaptation of skills** in the workplace, requiring significant investments in continuous training. In fact, experts agree that **mandatory continuous training should become the norm** for all professionals, regardless of sector, to keep their skills up-to-date and relevant. This mandatory training can be implemented through government policies, industry regulations, or company-level initiatives. **Training programmes are expected to evolve** over the next five years to **integrate digital and sustainability skills**. This includes introducing **specialised courses** in **environmental data analysis, green project management** and **sustainability consulting**. **Ethical considerations** should be incorporated into training programmes. This includes understanding issues such as **data privacy, algorithmic bias**, and the **environmental impact of digital infrastructure**. A strong ethical foundation is essential for ensuring that professionals are equipped to navigate the ethical implications of their work and that digital advancements align with broader sustainability goals. Training programmes should also incorporate **leadership development modules** that focus on **strategic thinking, communication**, and **stakeholder engagement**, as effective leadership is crucial for change and fostering a culture that values sustainability in the organisation As new roles emerge, **educational institutions** will also need to **adapt their offerings** to meet the demand for these specialised skills. Experts stress the need for a curriculum that integrates topics such as **circular economy models, renewable energy technologies,** and **sustainable product design.** The experts emphasise that **companies will need to collaborate more closely with universities and training institutes** to ensure that curricula are aligned with the evolving needs of the labour market, including providing feedback on required skills, offering internships and apprenticeships, and possibly co-developing training programmes. An IT sector expert expresses the dream of **supporting the elevation of collective well-being through sustainable practices**. This sentiment underscores the growing importance of sustainability in the business world and the need for training programmes that can equip professionals with the necessary skills to bring about positive change.
Nether-lands	In the Netherlands, experts expect **upskilling to understand sustainability data**. Due to legal requirements, large companies will face changes in their financial planning and control departments, where more data and other data points need to be collected and analysed.

	This is due to the fact that there are several legal requirements related to sustainability, and these need to be considered along with digital aspects when organisations undertake a twin transition. The experts note that companies struggle to understand the implications of regulations. The twin transition requires a good understanding of 'BLT': **Business-Legal-Technical** and **human rights** must also be included. Experts have **different opinions on other areas of upskilling**. Some experts argue that it is **not necessary to have all the expertise in-house**, nor is specific training and in-house training needed; it would be **enough to have an understanding of the dynamics, requirements and relevance of the digital sustainability transformation**. All experts agree on the need for **communication skills**. These skills are important **to explain why change is needed**, for example. The essential question remains: are people willing to change their behaviour?
Romania	The Romanian experts, coming from the IT industry, use the term **'sustainability debt'** (corresponding to 'technical debt'); by this they mean that any current compromise regarding profit over sustainability will later have a detrimental effect with unintended consequences. They further emphasise the **role of academia**, suggesting the **formation of an advisory board** with academic members to advise on sustainability decision-making. The experts argue that the academic environment should **continuously promote cross meta-skills** and **research institutes should help develop new digital and sustainability solutions**. This, according to the experts, requires **cooperation between the public and private sectors**. Education is crucial in equipping individuals with specific competencies and raising awareness about the importance of implementing sustainability. The long-term transition requires a change in attitude and behaviour. All company members should collectively be willing to invest more time in their digital sustainability education.
Slovenia	Slovenian experts find this difficult to predict for the long term, so no education/ training needs were reported. It is mentioned, though, that companies should train 1 or 2 employees to acquire the competences for the digital sustainability consultant role.
Spain	For the long term, Spanish experts expect a demand for **training for specialised roles/profiles**, focused on specific processes. The same general skillset will be needed, but different organisational units will require customised profiles. In particular, the **leadership role** will need specialised training.

7.6 Annex European expert panel

7.6.1 Debate description

ESG and pragmatism

[A] starts with pointing out that **companies are very pragmatic.** Does a new role create meaning, money and a future for the company? If it does not lead to turnover immediately, a new position may not be an issue if it is part of the company's development. **Sustainability is more than just calculating emissions, it is also behaviour change**, and this involves business- and product development rather than just ESG. In a

large company, the task of ESG reporting could be done by a dedicated administrative specialist, who is knowledgeable in legislation.

[B] Agrees with [A] that companies are pragmatic. **Companies need incentives to act**, like labels or legislation. Without that, it will be very difficult to make companies compliant. If there are obligations, for example related to the circular economy, in which you will need data to be exchanged in several parties within the company, automatically the skills will be needed to implement that.

[C] points out that **not everything is included in the ESG regulation**, although it is a good starting point. Given the fact that the IT industry is the 4th biggest polluter in the world, we need to find way to make it an obligatory process for companies to take care of their all digital processes and how much CO2 they produce. Currently, CO2 footprint is not obligatory under the ESG.

Sustainability is not just simply being compliant; it **involves a change of mindset and paradigms**, **[F]** states. Sustainability is a kind of innovation. It is a change that must be managed. Agrees with [A] there is a difference between large and small companies and that companies are very pragmatic. In some years, all companies will face more sustainability regulations. Currently, the **focus is too much on environmental sustainability;** on output, with labelling the energy consumption of technologies, looking at negative impact. The **focus should be broader** and take into account the positive impact and the broader set of stakeholders involved; it is about creating value in society, economy and env ironment. It is very complex, and sustainability should be part of the **governance structure** of any organisation. In a large organisation, the innovation department could be involved, in a small organisation the CEO.

[D] points out that **ESG is just a very small part in a much bigger process** and challenge for companies. When implementing sustainability solutions, many different roles in the company are involved, e.g. lifecycle assessment specialists, product designers, finance, marketing and communication etc.

[B] emphasises that big investments in innovation are more difficult for SMEs than for big companies. Although SMEs tend to be more flexible than bigger organisations, big investments are for them a bigger risk. So, it will become **very important for SMEs to cooperate,** having common innovation actions, it gets financeable for each small organisation.

Many roles

[E] states that **ESG is not the main job role, it is just one area**. Starting a sustainability project, creating new products or new software, this involves many parties, not just the software developers, but also other roles, like the sustainability office, HR, CSR, research, supply chain, infrastructure, real estate, etc. When creating a sustainability product, its **impact on all the parts of the whole organisation** must be taken into account, like data centre, infrastructure, data governance, developers, systems etc.

[C] adds that besides ESG and reporting, a person needs to have **both technical skills, know about ESG and some business skills to lead the way** and to make everyone aware on how sustainability supports both our planet and the business itself. Sustainable systems are almost always more optimised and better performing, so they work faster and cheaper.

Frameworks

[F] points out that we are trying to define a role that combines technical, sustainability and business skills that does not exists yet. There are several **frameworks** available at European level. The focus on digital transformation, including the sustainability aspects of an organisation, could be done by an innovation manager. Currently, a framework describing this role is under development[14].

[D] agrees with [F] on using standardised models and methodologies and adds that a company does not need to invest, as **there are standardised methodologies open for all enterprises,** including SME's. Federations make the life cycle assessment models available for their members.

[B] states that SME's probably are not very interested in those models. SME's are not that focused on reporting, only when they have to or if they need it to get qualified, for instance as a provider. SME's are much more focused on practical skills, which can bring added value to everyday business, like sustainable procurement and automation. **SME's are focused on the operational level of their business and on some reporting obligations**.

[F] partially agrees with [B], pointing out that in a couple of years also SME's need to be compliant to more European legislation. There are a lot of resources at European and global level, but a problem is that **those resources are a black box**. There is very little information on how to implement frameworks at European level. In relation to the role and competences needed, this should be as much as possible an internal role within the organisation and not an outside one, e.g. by using a consultant. Only maybe when it comes to sector specifics or to concrete regulation.

[G] From an education point of view, the issue is that there is **no common language**, not for digital skills for sustainability experts, nor for green skills for IT experts. **There are some European frameworks,** like DigComp, life competencies and GreenComp, but they are **not easy to translate into a curriculum**. So, there is a gap and a lack: Frameworks should be made easier to adopt by teachers, trainers and SME's. Actually, we have to make a new framework that matches competences. First, it must be clear if the focus is on digital skills for sustainability jobs or on green skills for IT jobs.

[14] Referring to a standard that is currently under development by CEN/TC389: "Innovation Management Professionals – Knowledge, Skills, Autonomy and Responsibility Requirements".

Complexity and system change

[B] Sustainability involves **a system change** and that cannot be reached simply through business as usual and considering sustainability as an add-on. For this system change you need thorough knowledge about the environment, about society etc. So, **it would be better to skill people who are already knowledgeable in the complex field of sustainability, instead of the other way around.**

[F] agrees with [B] that it needs **a systemic view on the three dimensions of sustainability: environment, society and economy.** The skills needed also depend on the **maturity level of the organisation** in relation to managing sustainability.

[H] Disagrees on the fact that sustainability would be the responsibility of just one professional. Given the complex nature of the topic, it should **rather be addressed by teams.** Also, **regulations and standards probably won't result in the needed change** and innovation. In comparison to other parts of the world, Europe is lagging behind in innovation, and this is probably caused by too many regulations.

[D] Often organisations invest first in a **transversal role** who works together with different departments, more based on a sustainability background. It involves IT, but does not specifically start with IT. The **most difficult role to fill is the one that relates to data, data quality and sustainability.**

[I] adds that it is important to take into account skills related to **'electricity'**. Understanding this is a very solid starting point. Also to prevent having one sold a 'magical solution'.

Besides, we have to think of what comes **after the twin transition**. What will become the **'new normal'**? Probably this will be **bio economy** and the **creation of local or regional supply chains**, instead of global ones. These aspect are **not part of the discussion now** and it is important to start addressing this, especially for youth and students who will be our future workforce.

[F] Energy consumption is critical, but this alone will not create climate change. More important is greenhouse gas emissions. There is a whole set of indicators to take into account when we consider sustainability, like energy consumption, greenhouse gas emission, the use of natural resources etc. We **need to have a common language** and a definition for this.

[C] provides a real-life example of miscommunication between the ESG dept (that wanted information on the CO2 production) and the developers in the IT team (that were unwilling to go through the regulations to see how they can explain and measure the impact of their department), that illustrates the **need for a role that understands both ways.** This role is missing at the moment. It is not about the regulations and the means; it is about real reduction. We need someone who knows about that.

[B] In related to [I] and [C] about resources: Currently, there is the tendency to think dematerialised, so not taking into account the analogue world. **Behind every digital application there is an analogue**

infrastructure, that should be taken into account when it comes to sustainability. Both the impact of the digital solution and the impact of the analogue infrastructure must be considered, to analyse whether a solution is globally positive or globally negative. The challenge is to make IT people think in terms of limited resources. This is not the case now.

Data

[F] Available data on sustainability is not the main bottleneck we are facing. How to manage data could be more critical than how to create data. There are many frameworks, but we have to implement those in different contexts. The **consultant can solve this gap** and advise on application of the framework in concrete contexts.

[E] It is actually about **having the right tools, so that the data is available and trusted.** Data must not be held in silos and not manually handled, which is prune to errors. Especially in larger companies this is very important; with different departments and eventually also dispersed across different countries, **data governance is needed, having data dictionaries in place so that assets and terminologies are used in the same manner across these different locations**. Blockchain might support in supply chain issues, IoT could help with energy reductions and robotics with the automation of the systems input. In general, **one needs to think about how a team and emerging technologies could help** to automate, simplify and enable informed decision making. **You need data to reach a sustainability goal, like energy reduction. This is important in any education**. Many experts agree with this point.

[D] It is important that people in organisations have enough **knowledge to connect the dots**. For example, from a leadership perspective, how does ESG reporting relate to reporting on the product level? From an application perspective, it is challenging to know which kind of tools and solutions you need, what is available in the market and how can these tools be connected to each other? Whether a tool is good or bad also depends on you particular need.

7.6.2 Summary of European expert panel

The experts started the discussion with stating that companies are very pragmatic and will assess if introducing a new role will add value to the business, in particular turnover. Besides, sustainability involves **behavioural change**, relating to business- and product development and not just some ESG calculations. **ESG is not the main job role**, it is just one area.

Labels and legislations are **incentives** for companies to act. Experts agree that sustainability is not just about simply being compliant; it involves a **change of mindset** and paradigms. In that sense, it is a kind of innovation; a change that must be managed. Currently, the focus is too much on environmental sustainability; on output, with labelling the energy consumption of technologies, looking at negative impact.

The **focus should be broader** and take into account the positive impact and the broader set of stakeholders. Sustainability should be part of the governance structure of any organisation.

When implementing sustainability solutions, **many different roles** in the company are involved, e.g. **lifecycle assessment specialists, product designers, finance, marketing and communication** etc. Besides **ESG and reporting**, a person needs to have both **technical skills** and some **business skills** to lead the way. One expert states that we are trying to define a role that combines technical, sustainability and business skills that does not exist yet.

Although SMEs tend to be more flexible than bigger organisations, big investments are for them a bigger risk. So, it will become very important for **SMEs to cooperate**, having common innovation actions, it gets financeable for each small organisation. SME's are much more focused on practical skills, which can bring added value to everyday business, like sustainable procurement and automation. SME's are focused on the operational level of their business and on some reporting obligations.

Experts note that there are a lot of resources at European and global level, but a problem is that those resources are a black box. There is very little information on how to implement frameworks provided at European level.

Digital 4 Sustainability
Skills for Europe's Twin Transition

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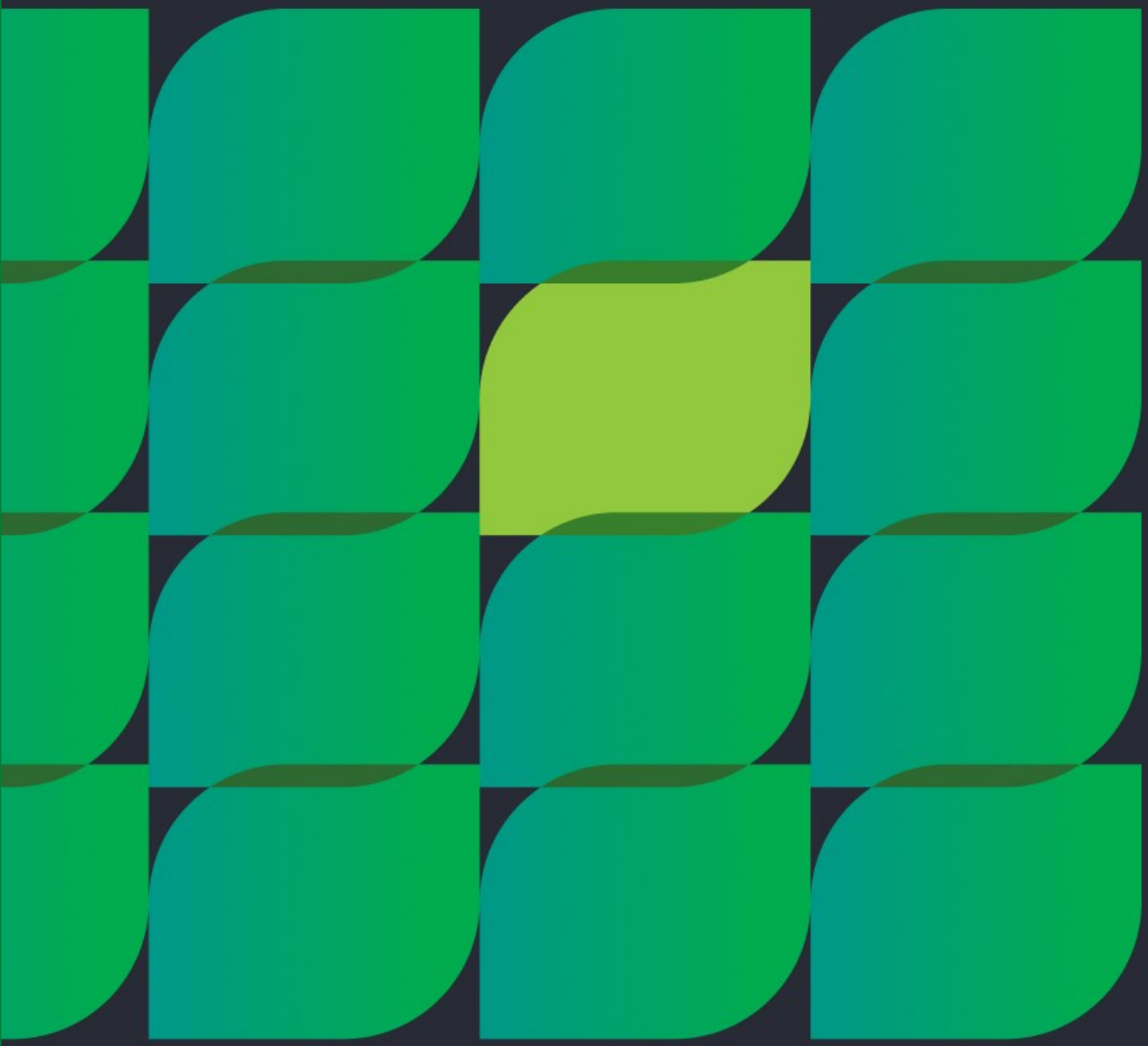

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