Deliverable 2.1

List of skills and competences for
different occupations and EQF levels in the
construction sector.

2024-01-24

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Scope/Description

The outcome of this task will be a list of skills and competences for each occupation and the respective EQF level, integrating the economic and innovation strategies and the market needs to support innovation and growth at local, regional, national and EU levels. These skills and competences will be subsequently integrated into the existing VET courses in T2.3 enriching the content and the VET provision formats with a transitional element.

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Introduction

The construction sector is vital to the EU's economy, contributing 6% to its GDP and employing 13.5 million people, or 6.6% of the EU-27 workforce in 2021. Its influence extends beyond direct employment, impacting job creation or loss in industries like steel, glass, and electronics, with an estimated 27 million jobs reliant on its performance.[1]

Despite an expected slight decline in construction employment by 1% from 2021 to 2035, equating to about 180,000 jobs, significant job openings are anticipated due to retirements and other factors, with about 7 million vacancies predicted in this period.[2]

Nearly a quarter of the current construction workforce is expected to retire in the next decade, with the sector's workforce crisis attributed to negative industry perceptions, a pre-existing skills shortage, and logistical challenges, especially in regions like Italy and Ireland.[3]

Technological innovations like Building Information Modelling (BIM), 3D printing, sensors, and AI could enhance productivity, but concerns remain about slow tech adoption, with surveys indicating limited use of digital methods in construction projects. Accelerated adoption of these technologies, supported by national and EU policies, is seen as essential, particularly for small and medium-sized enterprises. (ECSO, 2021)

The BuildSkills Academy project addresses the skills gap in the European construction sector by enhancing the training of Vocational Education and Training (VET) providers. Focusing on emerging technologies and sustainable practices, it will prepare VET providers to equip the future workforce for the green and digital transitions. This initiative, crucial for sector improvement and technology adoption, relies on a shared understanding among partner organisations of the need for upskilling and reskilling. For this reason, the project's initial phase involves a comprehensive list outlining key areas, occupations, skills, and knowledge for development, setting a collaborative foundation for advancing the industry's workforce capabilities.

[1] https://ec.europa.eu/eurostat/cache/digpub/housing/bloc-3a.html?lang=en

[2] https://www.cedefop.europa.eu/en/tools/skills-forecast

[3] https://build-up.ec.europa.eu/en/news-and-events/news/construction-skills-crisis-europe-and-possible-solutions

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Definition of a common understanding

If we look a bit deeper into the issues presented before, we can immediately recognise critical challenge arises from the considerable differences among partners, particularly in terms of their unique characteristics and varying degrees of international influence:

a. Supply Chain Vulnerabilities[4]: Although both Italy and Germany have robust manufacturing sectors, severe disruptions to global markets such as COVID-19 pandemic and Russia's invasion of Ukraine, have exposed common vulnerabilities to the supply chain. More than 80% of global production of raw materials is concentrated in 3 countries. Both countries are not only import-dependent, but also have a concentration of production. As for Greece and Cyprus, given its island character, its supply chains can be disrupted by natural disasters like floods or extreme weather, and man-made events like political instability. However, also the pandemic and war cumulatively affected their supply chain increasing the tanker freight rates.

b. Workforce Exit to Other Countries[5]: Labor migration in Western Balkans has led to a drain of skilled labour from their construction sectors. The migration patterns are shaped by several factors: A worsening socio-economic and political situation in home countries, decreasing labour standards, lacking employment opportunities, and deteriorating quality of life are considered as main reasons for leaving the region and looking for employment opportunities abroad. Bulgaria shortage of skilled and professional workforce in the construction sector reached 4.4% in 2023, while Bosnia and Herzegovina have the second-largest stock of migrants in OECD countries among the Western Balkans economies. Further, Serbia's skilled workforce availability is stagnant. 49% of employers identified a lack of skills and experience as one of the main obstacles to hiring. Similarly, Lithuania faces the same challenges due to emigration, ageing workforce and late payment issues.

c. Workforce Shortage[6]: The construction industry is increasingly reporting labour shortages in most of the EU Member States. In Germany the IFO institute reported the labour shortages at 49.7 in 2022, and in 2023, the Federal Employment Agency recorded around 52,000 vacancies in the construction sector. Most of the vacancies are for young trainees, while the demand for graduates is now limited. As for France, 74% of the 261,000 recruitment plans are estimated to be difficult to realise in the construction industry. Finally, Cyprus is grappling with a massive

[4] https://ec.europa.eu/research-and-innovation/en/projects/success-stories/all/reducing-vulnerability-global-supply-chains
https://cargoon.eu/en/news/the-impact-of-the-german-economy-on-the-supply-chain/
[5] https://eures.europa.eu/living-and-working/labour-market-information/labour-market-information-bulgaria_en
[6] https://pr.euractiv.com/pr/shortage-labour-construction-industry-255982

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demand for skilled workers with job vacancies exceeding 1,000 positions annually, while Greece labour market entered the COVID-19 shock following several years of sustained employment growth.

Given this complex landscape, it is imperative to establish a common understanding among all stakeholders. This shared perspective is essential to effectively address the multifaceted challenges faced by the sector, ensuring that strategies and solutions are tailored to accommodate the diverse needs and capacities of each partner. Such alignment is crucial for fostering collaborative efforts that can more adeptly navigate the intricate and globalized nature of today's construction industry.

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Definition of Topical areas, Occupations, and Transitional skills in construction

The first task has been the definition of a common understanding of transitional skills in construction, to determine the necessary elements for reskilling and upskilling within the industry and for advocating a standardised certification.

Building on the initial task of defining transitional skills in construction, the methodology for achieving this will be carried out by breaking down the concept into three distinct but interrelated layers: Topical areas, Occupations, and Skills. Each layer will be systematically addressed through a two-phase approach, described below, to ensure both thoroughness and accuracy.

For Topical areas, the first phase will involve a comprehensive review of existing literature, including academic and industry reports, policy documents and findings from previous relevant projects. This step aims to identify critical issues that reflect current and future trends in construction. Once these themes have been identified, the second phase of validation takes place. This involves cross-referencing the identified topics with findings from targeted surveys distributed to a diverse group of construction professionals and stakeholders from all partner countries. These responses, together with an analysis of national strategies and policies, will be used to either confirm or adjust the thematic relevance and applicability.

In focusing on Occupations, the European Skills, Competences, Qualifications and Occupations (ESCO) taxonomy will be used as the main source for the first phase. The comprehensive ESCO classification will provide a structured overview of occupations relevant to the construction sector, ensuring that the analysis is based on a widely recognised framework. The subsequent validation phase will again use survey feedback from industry professionals, compared with national and European occupational standards, to confirm the relevance of the identified occupations.

Finally, the first phase in addressing Skills will be to identify the competencies and skills that are essential for the modern construction workforce, guided by the findings of the previous two layers. Validation in this context will involve aligning the skills identified with the real needs expressed by the sector's workforce and with the strategic direction set out in national policy.

Through this two-step process for each layer - identification followed by validation - the project aims to establish a robust and consensual framework for transitional skills, thereby facilitating strategic reskilling and upskilling pathways in the construction sector.

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1. Approach for the scope definition of the Topical areas

1.1. Identification of the Topical areas

The first step for this definition is to identify the main challenges, objectives and expectations related to sustainability and digitalisation, the two parts of the so-called 'Twin Transition'. To this end, we adopt a secondary source approach, reviewing EU policies and taxonomy frameworks to extract key definitions, objectives, and strategies relevant to transitional skills in the European construction sector, including industry partners and market stakeholders.

The EU policies and taxonomy frameworks selected for analysis correspond directly to the European Union's overarching goals for 2050. These goals emphasise a significant shift towards sustainability, promoting the transition to a circular economy, reducing carbon footprints, and fostering resilience and innovation in industry. The policies and frameworks revised for this initiative are key elements in shaping the future of the European construction sector, ensuring that it aligns with the ambitious environmental and digitalisation benchmarks set for the next 30 years.

The revised documents include:

- **a.** EU Climate Adaptation Strategy: Outlining actions for more robust adaptation to the impacts of climate change.
- **b.** EU Taxonomy: A classification system establishing a list of environmentally sustainable economic activities.
- **c.** Energy Performance of Buildings Directive (EPBD) and Zero Emission Buildings (ZEB): Standards and initiatives to ensure that new buildings are highly energy efficient with net zero emissions.
- **d.** Circular Economy Action Plan (CEAP): Actions to stimulate Europe's transition to a circular economy, reducing waste and making sustainable products the norm.
- **e.** New European Bauhaus: An interdisciplinary initiative combining environmental solutions with design and aesthetics, reflecting the EU's cultural heritage and future aspirations.

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f. Renovation Wave: A strategy to increase the rate and quality of renovation of buildings in order to reduce emissions and energy consumption and to ensure a healthier environment.

g. Zero Pollution Action Plan: Aiming to reduce pollution to levels that are no longer considered harmful to health and natural ecosystems.

h. EU Forest Strategy: Addressing the multifunctional role of forests and promoting the highest level of biodiversity and sustainable management of forested areas.

i. Bioeconomy Strategy: Focusing on renewable biological resources and their conversion into vital products and bioenergy.

j. Scenarios for a transition pathway for a resilient, greener, and more digital construction ecosystem: Exploring potential futures and strategic approaches to achieve sustainability and digitalisation in construction.

In reviewing the aforementioned EU policy and taxonomy frameworks, we focused on four essential points to extract the most relevant information for the construction sector's transitional skills framework:

a. Targets: Examine the documents to find specific goals, objectives or outcomes. These may include professional development, new occupations or profiles, national or sectoral targets, project milestones, etc.

b. Focus areas: Analyse the content within the documents to identify areas or domains that require action or improvement in relation to construction and construction-related education.

c. Actions: Within these areas, identify the specific actions defined to achieve the proposed targets.

d. Potential skills and jobs: Identify any skills, competencies or qualifications described in the documents. This includes technical skills, soft skills, certifications or educational qualifications, and whether these are current or future skills. In cases involving skills shortages, career planning or curriculum development, extract data on potential occupations or roles mentioned in the documents.

From the analysis of these four points (Annex 1), i.e. understanding objectives (what needs to be achieved), focus areas (where action is needed), actions (how to achieve the objectives) and potential

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skills and jobs (what skills are needed and what job roles will emerge or need to be developed), we have identified eight emerging concepts, referred to as 'Topical areas'. These areas represent key directions or guidelines for future progress in the management and application of new technologies and the development of skills and knowledge in the construction sector. Together they form part of a framework that aims to identify gaps in both the construction industry and the education ecosystem and provide a baseline or starting point for further development and adaptation.

The eight Topical areas are:

1. **Net-Zero Carbon Emissions in Construction:** Achieving net-zero carbon emissions in the construction sector through energy efficient and building renovation practices.
2. **Circular Economy Practices:** Implementing circular economy practices considering new design and engineering methods, and material flow and waste management.
3. **Green Building Certification:** Scaling up green building certification.
4. **Sustainable Materials and Sourcing:** Embracing Sustainable Materials and Technologies, including digital technologies that support the transition as well as promoting sustainability and responsible sourcing throughout the construction supply chain.
5. **Climate Resilience and Adaptation:** Preparing construction projects to withstand and adapt to changing environmental conditions, including extreme weather events and resource scarcity in terms of climate change mitigation and adaptation.
6. **Occupant Health and Well-being:** Ensuring that construction practices prioritize occupant health, safety, and well-being through better indoor air quality, natural lighting, and ergonomic design.
7. **Automation for Efficiency and Sufficiency:** Increasing efficiency and sufficiency through automation, digital information and analysis and data acquisition
8. **Collaboration and Project Management:** Enhancing collaboration and project management with the help of digital technologies.

It is important to emphasise that **digitalisation** emerges as a critical enabler and undercurrent across these eight Topical areas, acting as a common denominator that facilitates and accelerates the transition towards the European Union's goals. It does not act as a single pillar, but as a cross-cutting asset that increases and refines the impact of each theme and strengthens the sector's trajectory

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towards meeting the EU benchmarks. Consequently, digitalisation cannot be siloed as a discrete topical area. Instead, it should be integrated throughout each of the eight topical areas, adapted in each case to achieve their respective objectives.

To complement the findings from these documents, an analysis of other relevant and similar EU projects was carried out. This additional research provided an understanding of the areas highlighted by recent initiatives and allowed for the incorporation of successful strategies and lessons learned. The assessment focused on how these projects addressed the twin challenges of sustainability and digitalisation, identifying gaps, commonalities and best practices that can inform and refine the definition of transitional skills in the construction sector.

The assessed projects include BluePrint in Construction[7], focused on Energy Efficiency, Circular Economy, Digitalisation; BUS-GoCircular[8], focused on three types of interventions in construction for Circular Economy (Multi-Functional Green Roofs, Facades, and Interior Elements); and PROF/TRAC[9], which specifically focused on Zero Net Emission. The specific scope of the projects examined underlines the advantages of a more targeted and narrower focus in terms of topical areas (a reduced number or only one in the case of PROF/TRAC), and potential jobs to be addressed. This approach limits the number of constraints, which simplifies the process of identifying existing and developing new specific skills, knowledge, and competences in the construction sector to be then piloted.

A narrower definition of its scope in terms of target areas and occupations, which would allow for more precise identification of skills gaps and the design of specific training frameworks, could be a more appropriate approach for the BuildSkills Academy project, ultimately ensuring that our results are closely aligned with industry needs and effectively contribute to the achievement of EU objectives.

1.2. Validation and prioritisation of Topical areas

In order to ensure that the initial findings (from the literature review) are not only theoretically sound but also practically relevant and responsive to the current and future needs of the construction sector in the consortium countries, a second phase of validation of the Topical areas is necessary. On the one hand, through the review of relevant national documents, the realities of the sector, emerging trends, required technological developments, strategic plans or national challenges will be identified. On the

[7] https://constructionblueprint.eu/

[8] https://busgocircular.eu/

[9] https://proftrac.eu/ (official domain currently not available; by 03.11.2023)

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other hand, the topical areas are assessed and prioritised according to the results of the surveys carried out with the different stakeholders in each partner country.

Accordingly, using direct feedback from the relevant stakeholders and the national literature serves several critical purposes:

- Relevance: It confirms that the identified Topical areas correspond to the real needs and priorities of industry stakeholders, including companies, policy makers and educational institutions.
- Accuracy: It verifies that the data and assumptions used in the initial analysis are correct and reflect current conditions and projections for the sector.
- Stakeholder engagement: It engages industry professionals and other stakeholders, ensuring that their expertise and experience informs the final prioritisation, which increases buy-in and support for implementation.

The inclusion of this validation step is also essential to optimise the scope of the project and enable a more targeted approach to the subsequent implementation and testing of the methodology, consistent with a pilot strategy. This step ensures that the project remains aligned with the practical realities and evolving needs of the construction sector and verifies the relevance and accuracy of our theoretical findings through the lens of industry stakeholders' perspectives and insights.

As stated before, we use the results of the two surveys of both construction professionals and training providers, as well as the results of the partners' review of relevant national documents (Annex 2) to this end, collecting information from Bulgaria, Bosnia and Herzegovina, Cyprus, France, Germany, Greece, Italy, Lithuania, Norway and Serbia. Regarding the topical areas and priorities, they show the following:

Surveys (n=100) targeting construction professionals, primarily contractors and builders from Bulgaria and design team members from Germany, Cyprus, and Bosnia and Herzegovina (Figure 1), identified **Net-Zero Carbon Emissions, Circular Economy Practices, Sustainable Materials and Sourcing, and Climate Resilience and Adaptation** as priority areas for the EU construction sector's future. **Occupational Health and Well-being** follows slightly behind with fewer selections. (Figure 2).

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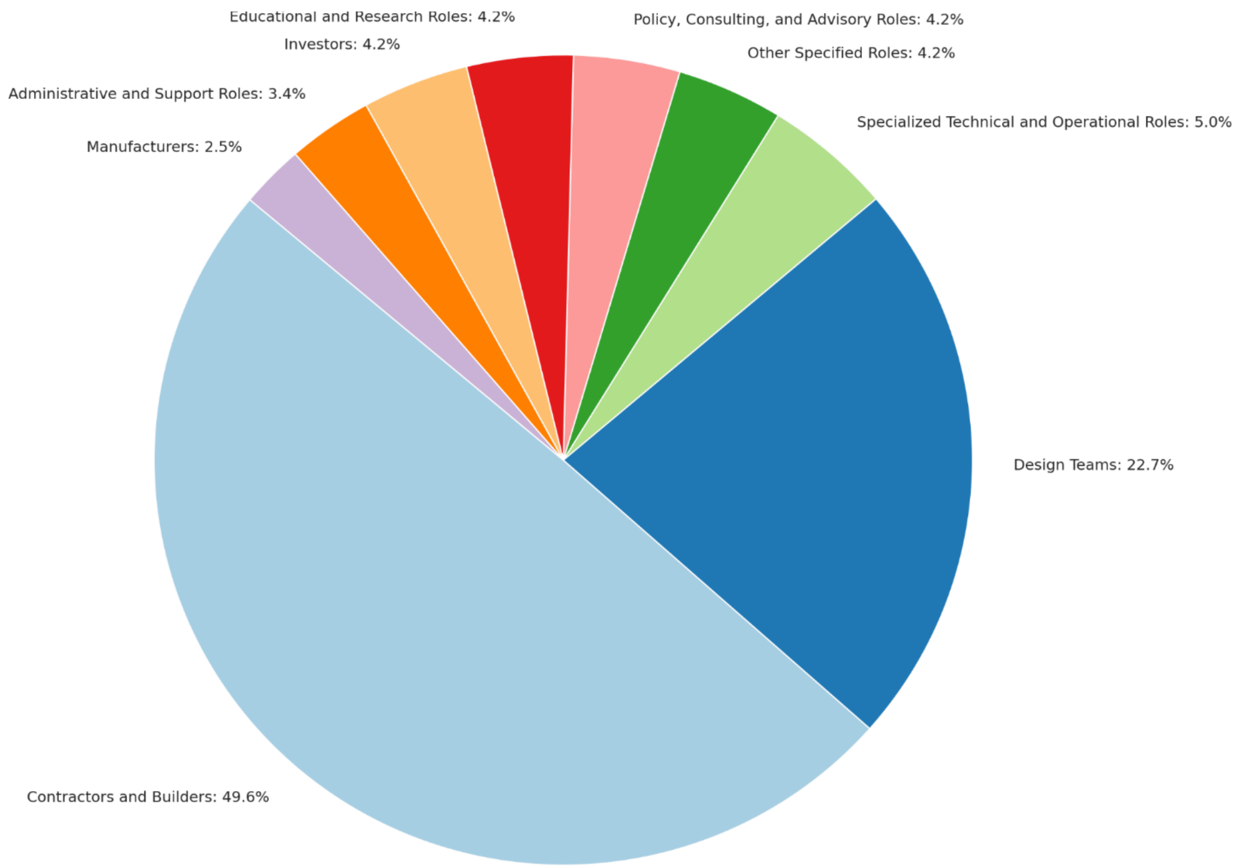

Figure 1: Survey 1 distribution of roles of targeted survey participants. Source: Own elaboration

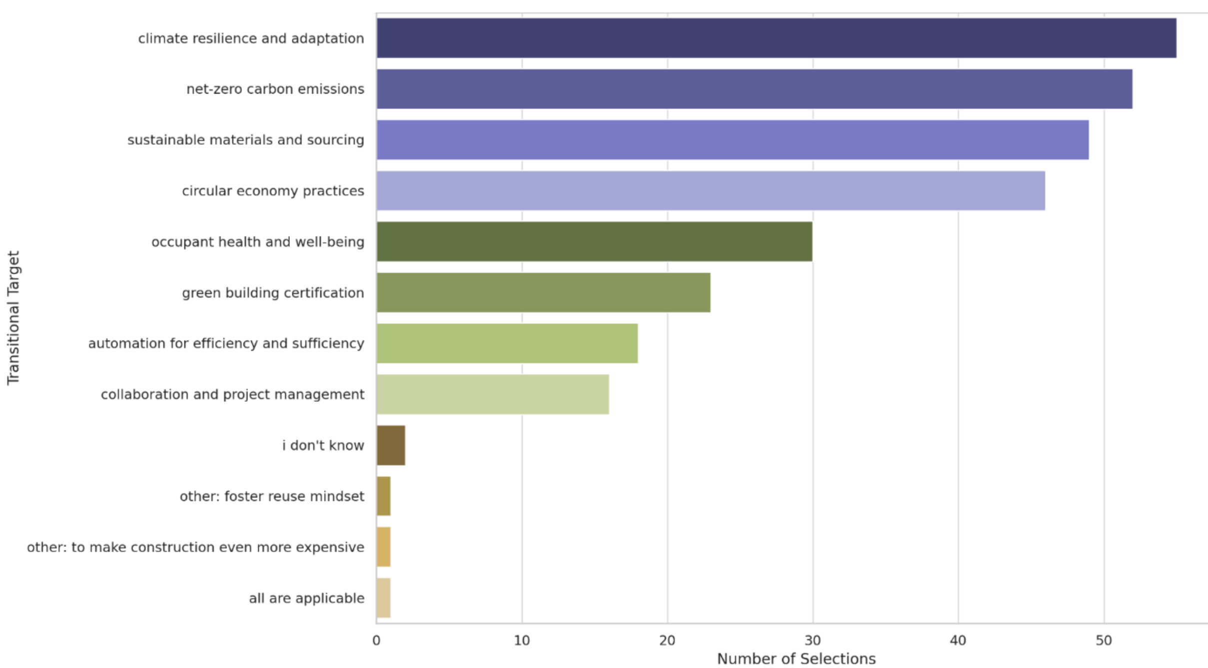

Figure 2: Survey 1, prioritised Topical areas by the Professional sector. Source: Own elaboration

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To achieve a more comprehensive insight into these general results, we undertook a correlation analysis for both the frequency of topical areas and roles outcomes. This analysis aimed to uncover whether certain targets were particularly relevant to specific roles. Our findings did indeed reveal these tendencies. We discovered that different stakeholder groups – contractors and builders, design teams, and investors and manufacturers – each showed distinct preferences and priorities when it came to transitional targets.

Responses from contractors and builders positively correlate with "Climate Resilience and Adaptation" and "Occupant Health and Well-being," indicating their keen interest in these areas. Conversely, "Circular Economy Practices" are less prioritised by this group, as evidenced by a strong negative correlation. Design teams, however, show a different pattern. Their priorities align strongly with "Sustainable Materials and Sourcing" and "Circular Economy Practices," suggesting significant emphasis on these targets. Interestingly, they seem to place less importance on "Climate Resilience and Adaptation," as indicated by a negative correlation. Among investors and manufacturers, the focus shifts notably towards "Net-Zero Carbon Emissions." This target demonstrates the strongest correlation, highlighting its significance in the agendas of these stakeholders.

Conversely, feedback from educational providers within the BuildSkills Academy consortium -gathered through our Input form- revealed a mismatch between industry needs and current educational offerings. Although Circular Economy Practices featured prominently in course offerings, there was a notable deficit in programs addressing Climate Resilience and Adaptation, which industry professionals had ranked as a top priority (Figure 3). Additionally, the prevalence of courses on Occupant Health and Wellbeing and Collaboration and Project Management surpassed the expressed needs of construction stakeholders, indicating a misalignment between educational focus and industry direction.

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Figure 3: Survey 2 (Input Form), prioritised topical areas by the VET sector. Source: Own elaboration

According to the national documents gathered and reviewed by our partners, the areas highlighted—Net-Zero Carbon Emissions in Construction, Circular Economy Practices, Green Building Certification, Sustainable Materials and Sourcing, Climate Resilience and Adaptation—are not only pertinent but also among the most relevant for their national construction sectors (Figure 4 and 5). Additionally, the documents reveal other significant areas such as Training and Education, Building Information Modeling (BIM), and Digitalisation (Figure 6). These are increasingly important in meeting the industry's evolving needs, with a specific focus on the development of training and educational programs. The focus extends beyond merely equipping workers with new skills; it targets educators themselves, addressing an acute shortage of qualified teachers and professors who can effectively transmit these advanced competencies. Moreover, digitalisation emerges as a consistent theme across the countries' priorities, reinforcing our stance that it acts as a catalyst for the green and digital transition.

Moreover, our analysis recognises crucial socio-economic elements, such as the integration of Small and Medium-sized Enterprises (SMEs), alongside tackling inequalities and addressing issues of workforce mismatching. We observe distinct challenges across different countries: for instance, Lithuania and Italy are grappling with retaining their workforce domestically, while Germany is challenged to effectively integrate migrant workforce.

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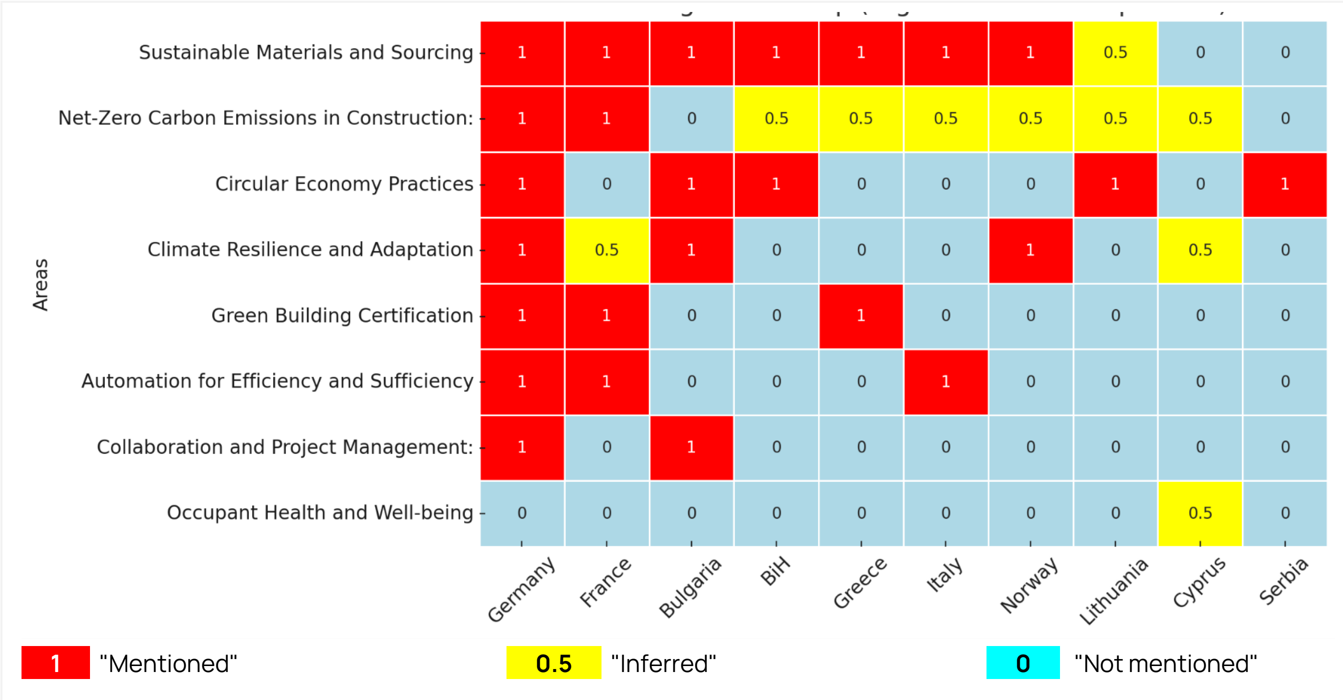

Figure 4: Mentions of the Topical Areas in relevant National documents. Source: Own elaboration

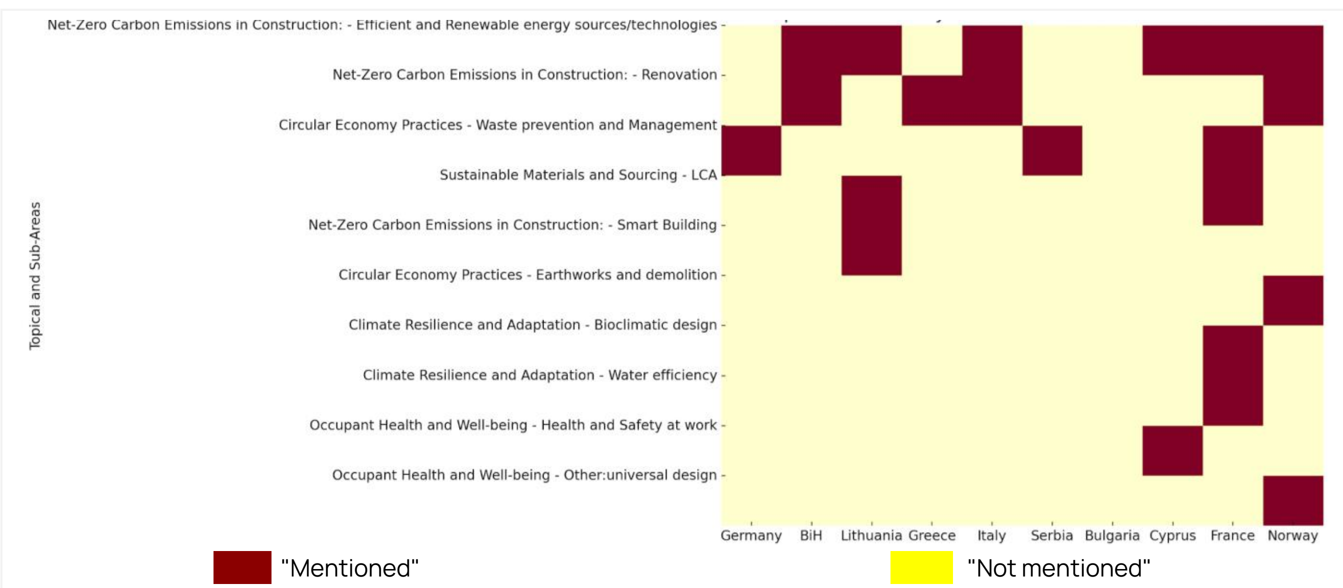

Figure 5: Mentions of Sub-areas in relevant National documents. Source: Own elaboration

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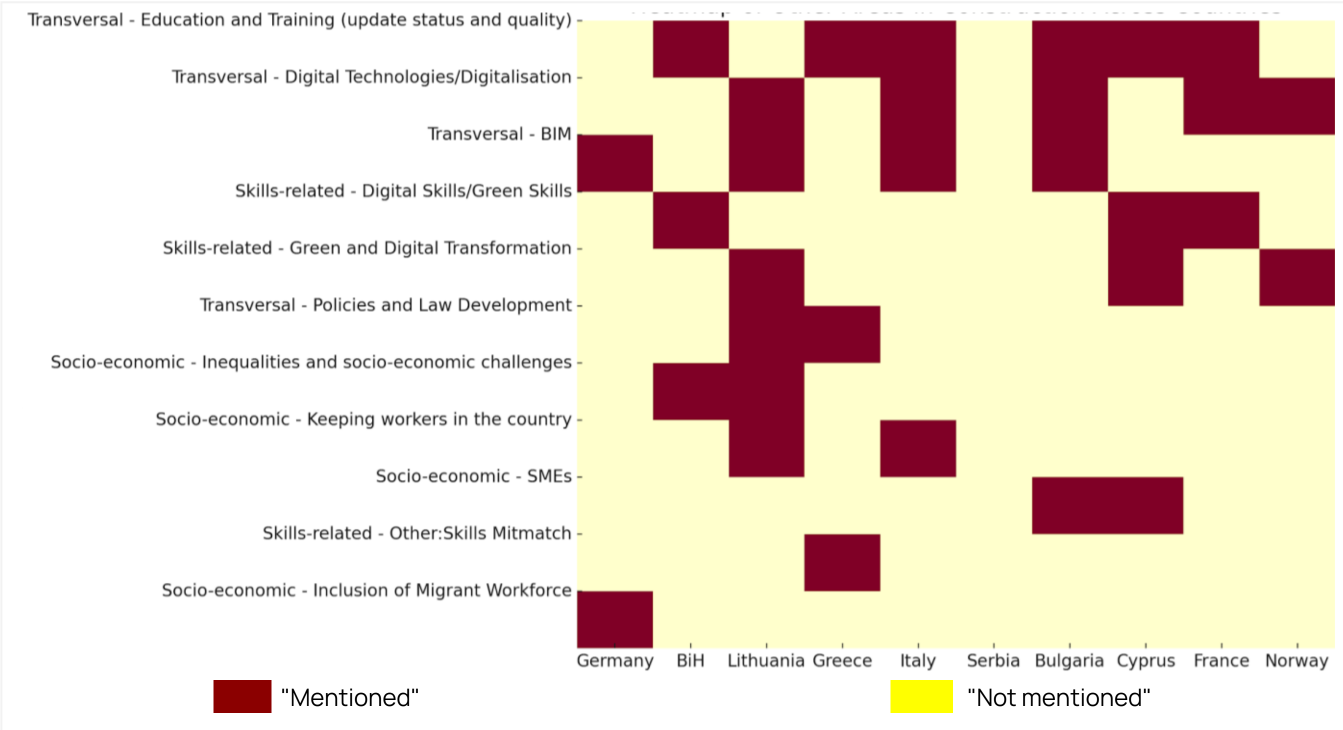

Figure 6: Mentions of other relevant areas in relevant National documents. Source: Own elaboration

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2. Approach for the scope definition of the occupation

In this second section, we turn our attention to the occupational framework within the construction sector, aiming to discern the current and anticipated workforce requirements. Our starting point is the European Skills, Competences, Qualifications and Occupations (ESCO) database, which offers a detailed catalogue of existing roles and competencies. This initial step provides a structured overview of the sector's professional landscape.

Building on the ESCO foundation, we integrate data from CEDEFOP and other pertinent European sources. This additional layer of research enhances our understanding of the sector's employment trends at the European level. These insights grant us a forward-looking view into the evolving demands of the construction industry.

Finally, we complement this overall picture with the practical insights gained from our surveys and review of national documents. By matching theoretical frameworks with empirical data, we validate and refine our findings, ensuring that our analysis is not only comprehensive, but also deeply rooted in the current realities and specificities of the EU construction labour market.

2.1. Identification of Occupations Scope from the ESCO analysis

This first step consists of the definition of the list of occupations to be considered for the development of the BuildSkills methodology, which starts with the revision of the International Standard Classification of Occupations (ISCO) framework developed by the International Labour Organization (ILO) to categorise and organise job information globally, and the new taxonomy developed by the European multilingual classification of Skills, Competences, Qualifications, and Occupations (ESCO), specifically regarding green and digital skills for the construction sector (version v.1.1.1, dated September 2022).This taxonomy is used to help bridge the gap between the world of education and the labour market by providing a standardised terminology that is understood across the European Union. The outcome of this analysis culminates in the compilation of a comprehensive inventory of occupations, and the green and digital skills, competences, and knowledge associated with each classification of ESCO occupations. (See Matrix).

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Once these occupations are defined, we categorise them according to the building lifecycle and map them to the different phases: plan and design, production, construction, use, and end of service life (disposal or deconstruction) (Table 1). This classification is used to structure our work and respond effectively to the evolving needs of the construction industry. By organising our approach from the start of a construction project through to its completion and beyond, we gain a clearer understanding of the different requirements at each stage. This systematic organisation facilitates a more strategic alignment of skills, knowledge and competences, allowing us to understand transitions between qualifications or cases of specialisation.

Table 1: List of ESCO occupations grouped according to the Building Lifecycle. Source: Own elaboration

Occupation Group ESCO	38 Occupations - Proposed EQF Level	Building lifecycle phase
Group 1: Construction Management and Engineering Professionals	Construction managers - EQF 6-7	Construction
	Civil engineers - EQF 6-7	Plan-Design
	Environmental engineers - EQF 6-7	Plan-Design
	Engineering professionals not elsewhere classified - EQF 6-7	General
	Building architects - EQF 6-7	Plan-Design
	Landscape architects - EQF 6-7	Plan-Design
Group 2: Technical Support and Supervision	Civil engineering technicians - EQF 5	Construction
	Electrical engineering technicians - EQF 5	Construction
	Draughtspersons - EQF 5	Construction
	Construction supervisors - EQF 5-6	Construction
	Valuers and loss assessors - EQF 5-6	End of Service Life
	Interior designers and decorators - EQF 5	Plan-Design
Group 3: Skilled Building Trades and Laborers in Construction	House builders - EQF 4-5	Construction
	Bricklayers and related workers - EQF 3-4	Construction
	Stonemasons, stone cutters, splitters and carvers - EQF 3-4	Construction
	Concrete placers, concrete finishers and related workers - EQF 3-4	Construction
	Carpenters and joiners - EQF 3-4	Construction
	Building frame and related trades workers not elsewhere classified - EQF 3-4	Construction
	Roofers - EQF 3-4	Construction
	Floor layers and tile setters - EQF 3-4	Construction
	Plasterers - EQF 3-4	Construction
	Insulation workers - EQF 3-4	Construction
	Glaziers - EQF 3-4	Construction
	Plumbers and pipefitters - EQF 3-4	Construction
	Air conditioning and refrigeration mechanics - EQF 3-4	Construction
	Painters and related workers - EQF 3-4	Construction
	Spray painters and varnishers - EQF 3-4	Construction

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	Building structure cleaners - EQF 3	Construction
	Civil engineering labourers - EQF 3	Construction
	Building construction labourers – EQF 3	Construction
	Refuse sorters - EQF 3	End of Service Life
Group 4: Metal and Structural Workers	Sheet-metal workers - EQF 3-4	Construction
	Structural-metal preparers and erectors - EQF 3-4	Construction
	Riggers and cable splicers - EQF 3-4	Construction
Group 5: Machinery Operators, Technicians and Plant Specialists	Wood treaters - EQF 3	Construction
	Cement, stone and other mineral products machine operators - EQF 3	Construction
	Crane, hoist and related plant operators - EQF 3-4	Construction
Group 6: Business and Administration in Construction	Business services and administration managers not elsewhere classified - EQF 6-7	General

However, the list of occupations compiled from the ESCO database provides a contemporaneous overview of the job titles and skills prevalent in today's labour market. The ESCO database bases on current observations and real-time data, representing a cross-section of the existing workforce and its qualifications. It does not extend to predict or anticipate the types of occupations, skills and knowledge that might become necessary in the future as the labour market evolves.

Given this present-focused purview, the validation of the occupations list becomes imperative. Such validation serves to evaluate the ongoing applicability of the listed occupations and to consider potential shifts and future developments in the labour market.

2.2. Validation and prioritisation: Revision of European Union data

According to CEDEFOP's skills projections[10]employment in construction will follow a downward trend, affecting mainly medium and low-skilled positions. The construction sector's shift towards higher-skilled roles is marked by a 10% decline in core worker employment since 2009, with a further 10% drop expected by 2035.

Meanwhile, an ageing workforce and high retirement rates will necessitate substantial recruitment in principal roles like construction labour. Science and engineering roles are also rising in prominence, reflecting the sector's move towards innovation and technology. This trend includes growth in

[10] https://www.cedefop.europa.eu/en/news/skills-developments-and-trends-construction

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electrical engineering and management-related occupations, signalling a significant skillset evolution within the industry (Figure 7).

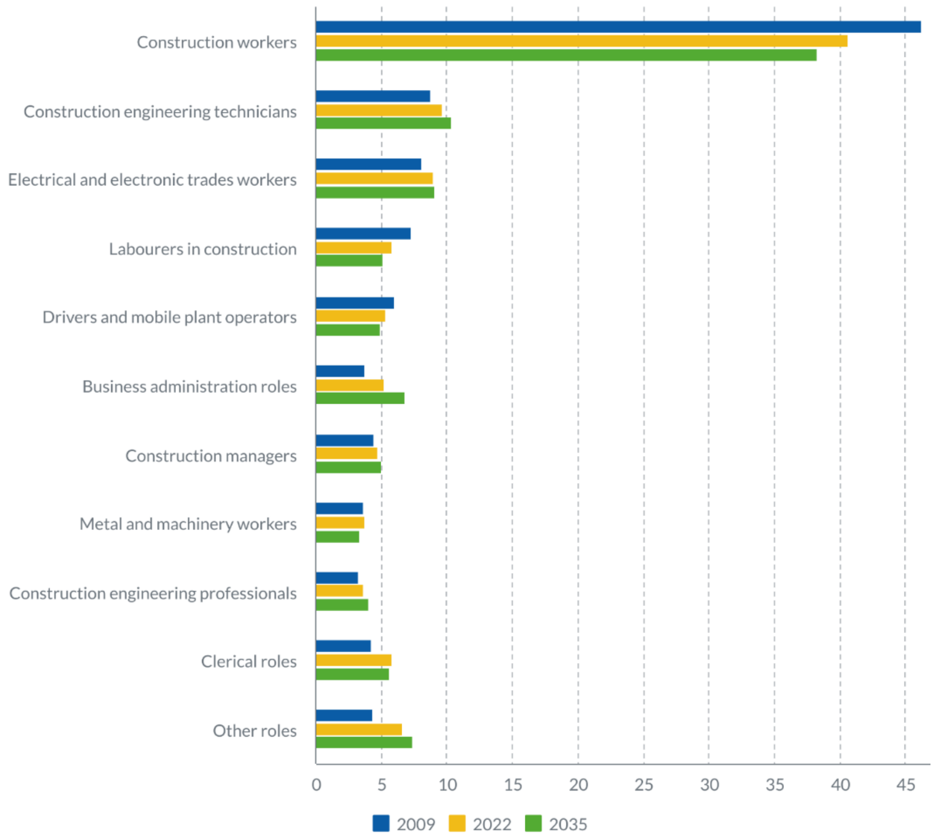

Figure 7: Employment shares of key occupations in construction (in %). Source: Cedefop Skills forecast database.

In response to transitions towards sustainability and digitalisation, coupled with supply chain disruptions and inflation, the industry is expected to increasingly integrate technologies that drive efficiency and skill shifts towards advanced construction methods.

The sector's employment structure, with a high volume of small-scale businesses, presents significant reskilling challenges. Failure to adapt to these emerging skill demands may limit the sector's ability to tackle present and forthcoming skill challenges.

Vocational education and training (VET) providers are anticipated to face difficulties in fulfilling future skill requirements of the construction sector. Persistent effort to devise new strategies is essential to mitigate the impact of digitalisation, ecological transitions, and an ageing workforce.

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Finally, the task of providing construction workers with appropriate skills will involve both foundational and advanced VET entities. Emphasising apprenticeships could enhance the appeal of the sector to younger individuals and women, enriching the talent pool.

Regarding jobs and skills requested in online job advertisements, according to the CEDEFOP in 2022 construction represented 2.7% of all online job searches in the EU27. The Top skills in online job advertisements for Knowledge, collected from all EU27 in 2022 were Business and administration, with the highest value of 32.2% (ESCO level 2, likely to represent a more specialised set of knowledge-based competences within various occupational fields), while Engineering is in fourth place with 10.5 % and Architecture and construction 3,9%.

Within the sector of Engineering and in direct relation to construction, the top occupations were for Assemblers (52,1%) and construction workers (12,4%). Ireland has the highest value with 19.1% in requesting Engineering in online job ads in 2022, followed by Slovakia, Italy, and Belgium. [11]

However, within the specific sector of Architecture and construction, which was only 3,9% of requested skills in online job ads in EU27 in Knowledge in 2022 (ESCO level 2), assemblers had a lower percentage of 4,7% and construction workers of 9,9%. In this case, Spain has the highest value with 9,7% in requesting Architecture and construction in online job ads in 2022, followed by Slovakia, Italy, and Belgium.

Regarding skills for the green transition, CEDEFOP outlines in its policy brief "From linear thinking to green growth mindsets"[12] that in the construction sector, a profound change in construction-related jobs is expected to be created or transformed as a result of the transition to a circular economy.

Some could be:

1. Jobs in building renovation: Construction workers will increasingly focus on renovating buildings rather than constructing new ones. This shift will require them to become proficient in the use of new materials and techniques that are more sustainable and in line with circular economy principles.

2. Modular construction: New business models such as modular construction, in which buildings are constructed in such a way that components can be easily dismantled and

[11] https://www.cedefop.europa.eu/en/tools/skills-intelligence/skills-online-job-advertisements?country=EU27_2020&year=2022#3

[12] https://www.cedefop.europa.eu/files/9184_en.pdf

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reused, are expected to grow. This approach is likely to create jobs that require different skills than traditional construction methods.

3. Green transition trends: Construction employment will also benefit from broader green transition trends, such as the expansion of renewable energy production capacity and the renovation and upgrading of buildings to improve their energy efficiency.

4. Industrial symbiosis: The document also mentions industrial symbiosis, which, while not exclusive to the construction sector, involves the sharing of services and utilities between industries. This could create opportunities for construction professionals to work on projects that integrate different sectors and require a wide range of technical and soft skills.

5. Deconstruction specialists and secondary materials markets: Although not explicit, the document also implies the role of specialists in the strategic dismantling of buildings, ensuring maximum recovery and reuse of materials, as well as in the development of advanced eco-design regulations and secondary materials markets.

At the same time, these changes will require and be driven by an increased use of digital technologies[13]. This development will not only create demand for new skills, but will also increase the productivity of the sector. Some of the new roles emerging from these new skills and linked to digitalisation include:

- data analysts;
- robot programmers;
- robot managers (operating also robotic systems used in a manufacturing environment);
- construction drone pilots;
- sensor installers and operators;
- AI-assisted architects;
- design automation experts (using key tools such as 3D modelling);
- cybersecurity experts;
- GIS specialists;
- innovation and integration experts.

Analysing market trends and job vacancies for forecasting purposes, CEDEFOP's findings show a steady increase in high-skilled jobs in the construction sector over the past decade (Figure 8), as indicated by both employment data and trends in online job advertisements (OJAs)[14]. This pattern suggests a

[13] https://www.cedefop.europa.eu/en/data-insights/greening-eu-construction-sector

[14] https://www.cedefop.europa.eu/en/data-insights/greening-eu-construction-sector#_skills_in_demand_the_evidence_from_ojas

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significant shift towards more high-skilled jobs in the sector. It's important to note, however, that OJAs have a representation bias that favours high-skilled jobs, which may distort perceptions of demand for these roles.

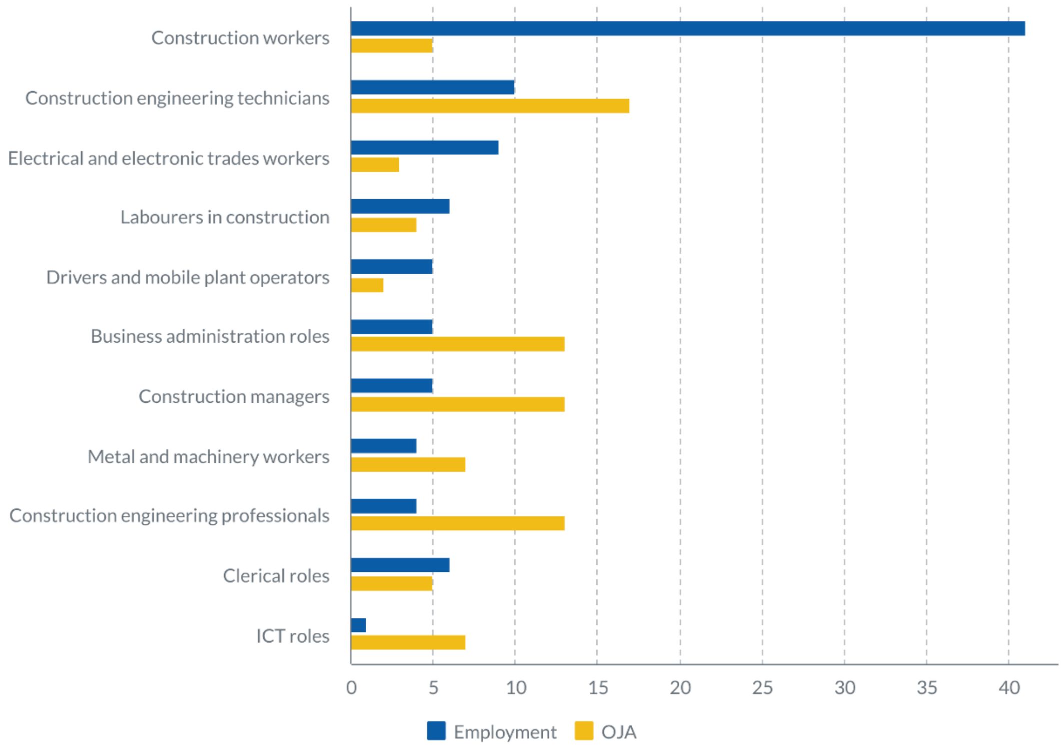

Figure 8: Construction sector: Occupation shares in OJAs and in employment (in %). Source: Cedefop Skills OVATE and European Labour Force Survey.

2.3. Validation and prioritisation: Revision of the Surveys and National Documents

As stated earlier, the analysis of topical areas from the survey conducted among Vocational Education and Training (VET) providers and other educational partners highlighted a prioritisation of courses related to Circular Economy Practices in general. However, further insights emerge when reviewing the courses in more detail, particularly regarding the content and structure of current course offerings in the realm of Circular Economy Practices and job qualifications.

A closer inspection of the described courses reveals that, despite the identification of Circular Economy practices as a key theme, the content tends to concentrate more on general learning and soft skills,

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with little specific focus on the Circular Economy's technical or practical aspects, particularly regarding the construction sector. This disparity indicates a dual possibility: firstly, the existence of a latent demand for more comprehensive and focused courses on Circular Economy, and secondly, a potential gap in knowledge or misapprehension about these practices among course designers. This divergence presents an opportunity for educational institutions to craft more refined and specialised courses for future professionals.

Delving deeper into the issue, the findings from the review of national documents also provide interesting insights that support the argument regarding the gap in circular economy (CE). In particular, while the circular economy is consistently high in terms of mentions in these documents, there is a striking disparity in its representation in the section describing potential future jobs (Figure 9). The number of job roles or career paths explicitly linked to the circular economy is minimal, suggesting a disconnect between the perceived importance of CE in policy and its practical application in the labour market.

This discrepancy is further illustrated when examining the European Skills, Competences, Qualifications and Occupations (ESCO) categorisation. In ESCO, all skills, knowledge and competences related to the circular economy are succinctly summarised under the term 'circular economy knowledge'. However, this broad categorisation does not delve into the specifics such as detailed skills, content areas or technical levels associated with CE.

The absence of detailed, specialised skills and knowledge in CE reflects a wider gap in the current educational and labour market landscapes. It implies that while the concept of the circular economy is recognised as important and frequently discussed at a policy level, and categorised as “existent”, in reality this recognition has not sufficiently translated into concrete educational pathways or clearly defined job roles.

Our review of the national documents also shows a remarkable consistency with the survey results, particularly in the importance of areas such as Sustainable Materials and Sourcing and Net-Zero Carbon Emission Buildings (NZEB). This is reflected in the significant number of potential job opportunities mentioned. (Figure 9)

In the area of sustainable materials and sourcing, design-related roles, particularly those involving engineers, are the most commonly cited. These jobs are mainly concerned with the creation of new products and components. Conversely, in the NZEB sector, the focus is largely on roles related to energy efficiency technology. These include a wide range of jobs, from technicians and installers to designers and assessors. Insulation workers and specialists are also mentioned.

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		Germany	Cyprus	France	Greece	Italy	Lithuania	Bulgaria	BiH	Serbia	Norway
Autom.	EXPERTS in home automation, smart lighting and low environmental impact plant management					Yes					
Autom.	robot resource manager			Yes							
Autom.	Data Management		Yes								
Autom.	Cybersecurity,		Yes								
BIM	Construction managers						Yes				
BIM	structural designers						Yes				
BIM	employees of public institutions.						Yes				
BIM	BIM MANAGERS, and more in general experts in the green public procurement applied in the building sectors					Yes					
CEP	Waste management coordinator			Yes							
CEP	Construction Impact Assessment Specialists			Yes							
CRA	Landscape Architects: Specialists in designing outdoor spaces that are both functional and environmentally	Yes									
CRA	Sustainable Infrastructure Engineers: Engineers who design and oversee the construction of green	Yes									
CRA	Water Resource Engineers: Specialists in the design and management of water and wastewater treatment	Yes									
CRA	Risk Management		Yes								
CPM	construction VR specialist			Yes							
CPM	digital construction manager (BIM related projects)			Yes							
CPM	site drone manager			Yes							
CPM	Sustainable construction manager			Yes							
CPM	Agile		Yes								
CPM	DevSecOps		Yes								
CPM	Cloud Management		Yes								
CPM	Change Management		Yes								
Digit.	IT professions.	Yes									
Digit.	Digital Construction Trainers: Professionals who teach digital tools and software relevant to construction, such as BIM.	Yes									
Digit.	ENVIRONMENTAL COMPUTER SCIENTIST: develops software and applications dedicated to the environment, using the most innovative techniques, such as green building.					Yes					
Digit.	administration experts in digitalisation							Yes			
Digit.	Teachers in VET and Higher Education							Yes			
General	Technical professions.	Yes									
General	Professions in the construction industry.	Yes			Yes						
General	Professions related to the operation of vehicles and transport equipment.	Yes									
General	Planners and construction companies in ensuring high planning and construction quality	Yes									
General	STEM		Yes								
OHWB	User-Centered Design,		Yes								
Renovati	professions related to building and renovation	Yes									
SMS	Building and supply technology professions.	Yes									
SMS	Designer of individual components and assembly catalogs.	Yes									
SMS	ECODESIGNER: a professional who designs innovative and above all sustainable products and services with a very low environmental impact from production to use and disposal or, better still, recycling or reuse.					Yes					
SMS	BIOMAKERS: craftsmen who are experts in the knowledge of new sustainable materials and can use them correctly					Yes					
SMS	Engineers developing Digital ID for buildings				Yes						
SMS	LCA specialist			Yes							
SMS	Green materials engineer			Yes							
Tech	Innovation Consultants: Professionals who assist construction firms in implementing innovative techniques	Yes									
Waste	Persons in charge of construction, management or supervision of the operation, or for after-care for the landfill	Yes									
ZNEB	Energy Auditors: Professionals who assess the energy needs and inefficiencies of buildings.	Yes			Yes						
ZNEB	HVAC Technicians: Those specializing in modern, energy-efficient heating, ventilation, and air conditioning	Yes			Yes						
ZNEB	Insulation Specialists: Professionals trained in advanced insulation techniques.	Yes	Yes								
ZNEB	Environmental Engineers: Professionals who ensure that infrastructure projects have minimal negative	Yes									
ZNEB	environmental protection sector						Yes				
ZNEB	ENERGY ENGINEER, who is able to design industrial, civil, transport or agricultural plants that reduce the consumption of energy and raw materials.					Yes					
ZNEB	Installers of all new technology related to Energy efficiency in New and renovating buildings				Yes						
ZNEB	Building Energy Manager				Yes						
ZNEB	Inspectors of new technology for energy efficiency				Yes						
ZNEB	Renewable energy engineer			Yes							
ZNEB	Environmental services specialist			Yes							
ZNEB	Renewable energy system installer			Yes							
ZNEB	Insulation workers		Yes								
ZNEB	Glaziers		Yes								
ZNEB	Plumbers and pipe fitters		Yes								
ZNEB	Air conditioning and refrigeration mechanics		Yes								
ZNEB	Building electricians		Yes								

Figure 9: Mentions of Potential future jobs in relevant National documents. Source: Own elaboration

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A second conclusion to be drawn from the VET Input Form results is that most of the courses focusing on the Topical areas identified tend to consist mainly of elective modules (Annex to the survey), either within a larger programme or as a complement to previous training. This pattern suggests that while these subjects are readily available to learners, they have not been integrated as essential components of the standard curriculum. Such an approach demonstrates a degree of adaptability in the educational structure, allowing students to select these modules according to their personal interests or professional needs. However, it also suggests that these subjects are not yet recognised as core elements within the broader educational framework.

Another factor to consider is that these modules are particularly prevalent in Master's level courses and in those designed for white-collar professions. In sharp contrast to this finding is the result of the stakeholder survey, which emphasises the need for up-skilling and re-skilling, especially within the skilled building trades and labourers (Figure 10). Stakeholders place a high priority on the development of skills and knowledge for construction workers, suggesting a need for more comprehensive and mandatory training in these areas. This discrepancy highlights a potential mismatch between course provision and the actual needs or preferences of industry stakeholders, particularly in the context of equipping construction workers with the necessary skills and knowledge. The gap between the flexible, optional nature of current courses and stakeholders' calls for more targeted training underlines an opportunity for educational institutions to review and possibly restructure their programmes to better meet industry needs and expectations.

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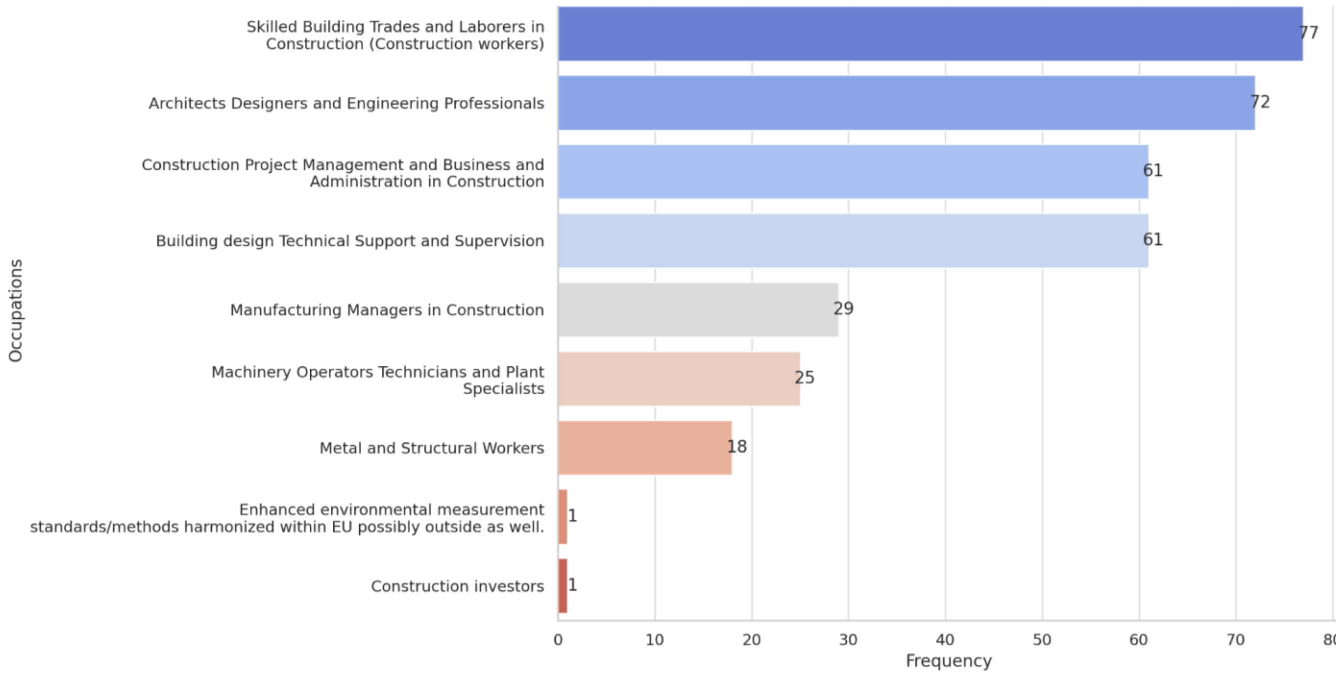

Figure 10: Survey 1, Occupations most in need of reskilling or upskilling to meet future targets according to stakeholders. Source: Own elaboration

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3. Approach for the Skills gap

For the final part of our analysis, we return to our examination of the ESCO (European Skills, Competences, Qualifications and Occupations) list for our selected occupations. From this selection, we analyse the green and digital skills, knowledge and competences, further categorised into essential and optional. (See Matrix).

During this analysis, we identified two main critical aspects within the ESCO framework that pose a significant challenge to our scope for identifying the skills and knowledge required for the green and digital transition in construction: the non-predictive nature of the taxonomy and the non-qualified classification. Therefore, a second level of analysis was required to ensure the effectiveness of our results.

For this purpose, we first contrast the green and digital skills outlined in the ESCO list with additional sources such as the European Union's information on construction skills and CEDEFOP (European Centre for the Development of Vocational Training) forecasts. These sources reflect the skills expected or required for the transition.

Subsequently, we align this data with our analysis of Topical Areas and Subareas validated and prioritised according to the insights gleaned from our surveys and review of national documents. This two-step process will ensure a comprehensive understanding of the skill sets necessary for the green and digital transformation within our scope of study.

3.1. Identification of Skills, Knowledge, and Competences from ESCO

As the information from ESCO is sorted in different datasets for occupations and skills and knowledge, the identification of skills, knowledge, and competences for the green and digital transition in the construction sector from the ESCO database required a merging process, which was carried out in two distinct steps:

In the first step, the identified occupations were cross-referenced with the ESCO list of skills, competences, and knowledge. For this purpose, the 38 occupations identified in the previous phase had to be disaggregated one sub-level further in order to match the ESCO's dataset for Skills/Competences/Knowledge (version v.1.1.1 of September 2022).

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The second step was to sort the results into green skills and digital skills and knowledge. As the categorisation of these two groups was developed by ESCO for all their databases (not just those related to construction), we had to match our identified occupations with the general skills and knowledge dataset and then with the green and digital categorisation. The total number of green skills for all selected occupations corresponded to 618, while digital skills were 361 (See Matrix)

3.1.1. Challenges identified in Skills, Knowledge and Competences from ESCO

In order to identify a potential skills gap from this data, it's important to understand the structure and nature of this taxonomy, especially given the wide range of skills and knowledge it covers.

We have identified two main critical aspects within the ESCO framework that pose a significant challenge to our scope for identifying the skills and knowledge required for the green and digital transition in construction:

- **a.** Nature of the ESCO List: As mentioned earlier, the ESCO list functions as a repository of current skills and knowledge, rather than a predictive tool, which therefore also extends to their definition of "essential" and "optional" categories. This condition limits its utility in forecasting future skill requirements.
- **b.** Classification Methodology: The ESCO list categorises skills, knowledge and competences into four broad groups: Knowledge, Language skills and knowledge, Skills, and Transversal skills. These are then organised by individual occupations and further aggregated into an eight-level hierarchy. However, this classification lacks specificity in terms of fields or areas relevant to the green and digital transition. Consequently, the list's utility in our context is constrained by its general nature and occupational-centric approach.

These challenges indicate that the data derived from the ESCO list needs thorough cross-referencing with other sources or frameworks to accurately identify gaps in skills, knowledge, and competences that are essential for the construction sector's transition. This cross-referencing process will be elaborated in the subsequent phases of the analysis, ensuring a more targeted and effective identification of the required skills and competences.

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3.2. Validation: Revision of European Data

The complexity of the required skills analysis can be illustrated by the results of Cedefop's second European Skills and Jobs Survey[15], which revealed a contradiction in workers' perceptions. While workers do not perceive a significant skills shortage in their current jobs (especially for digital skills), they recognise the importance of upgrading both technical and soft skills for future career growth and flexibility in an evolving industry (see Figure 11).

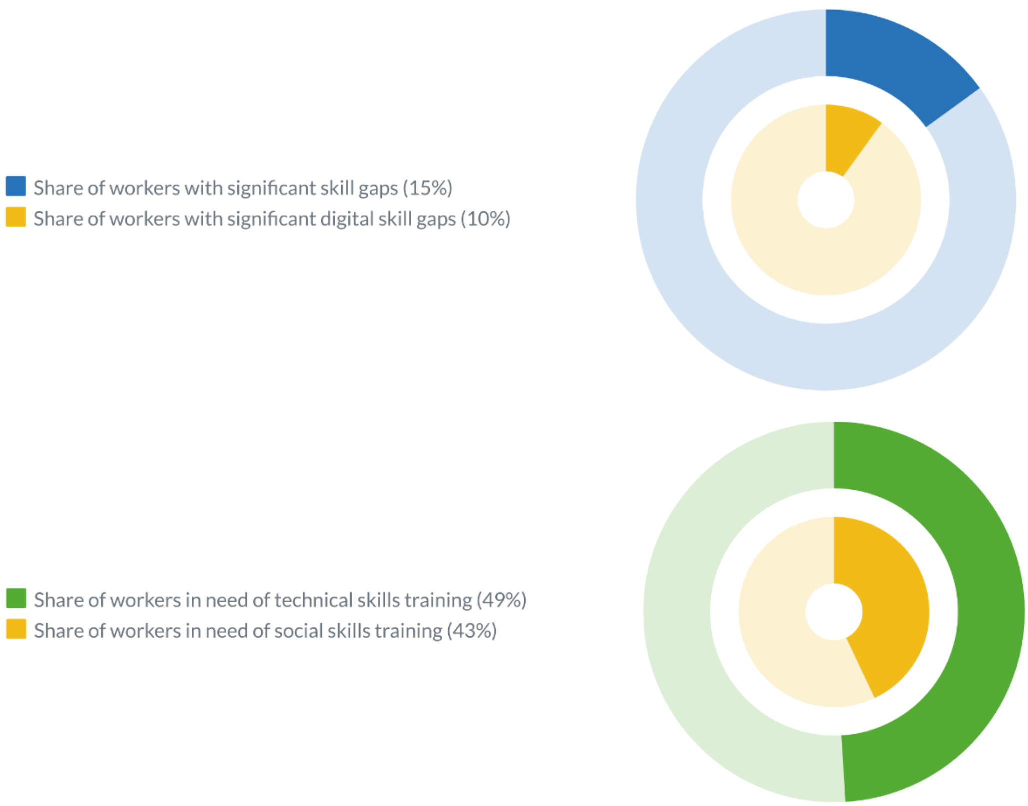

Figure 11: Skill gaps and skills training needs. Source: Cedefop second European Skills and Jobs Survey (2021)

According to the same survey, the construction sector also appears to face significant skills mismatches (Figure 12). Some 27% of its employees claim to have qualifications that exceed the requirements of their job, a situation that may be particularly prevalent among immigrant workers in the sector. In addition, a similar proportion of construction workers (27%) have only lower secondary education or less (ISCED 0-2). This latter group is particularly vulnerable to job loss due to increasing or

[15] https://www.cedefop.europa.eu/en/data-insights/greening-eu-construction-sector#_skill_needs_in_construction_the_vet_response

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changing skill requirements and generally corresponds to those with limited access to training opportunities.

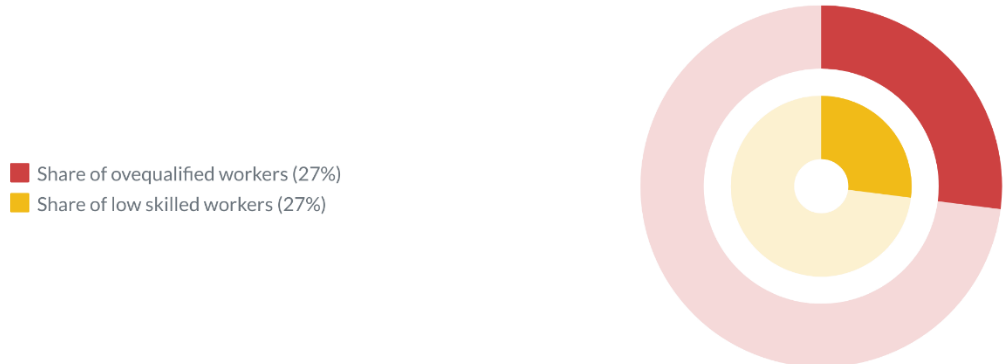

Figure 12: Low-skilled and overqualified workers. Source: Cedefop second European Skills and Jobs Survey (2021).

Online job advertisements (OJAs) - another CEDEFOP input that serves as a key indicator of the most sought-after skills and qualifications - show that teamwork has emerged as the most important skill in the construction sector in 2022, appearing in almost half of all advertisements. The most significant increase in skills was in the use of CAD software and creative design - an increase more pronounced than for general ICT skills (Figure 13).

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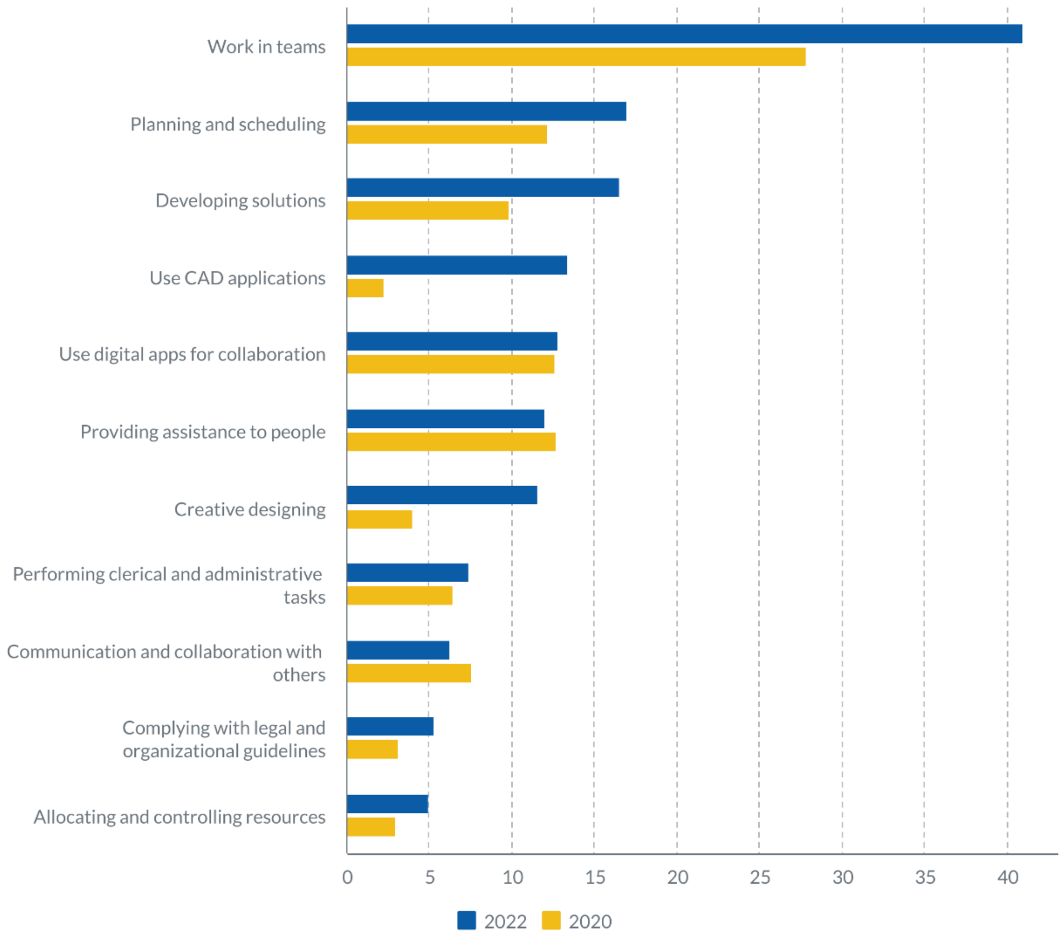

Figure 13: Construction sector: Occupation shares in OJAs and in employment (in %). Source: Cedefop Skills OVATE

The European Construction Sector Observatory (ECSO, 2020) has also identified this need for re-skilling and up-skilling in the construction sector and has organised these needs by construction phase[16]. For example, in the pre-design phase, skills in analytical and planning tools are essential to balance environmental, economic and legal factors, so that professionals can gather requirements and conduct site analyses in preparation for sustainable and energy-efficient (EE) designs. (Figure 14) During the design phase, professionals, including designers and architects, need technical skills and knowledge of digital tools such as BIM to integrate sustainable considerations such as EE, waste management and climate adaptability. In the tendering phase, contractors need to understand green procurement and resource efficiency, including waste minimisation, while in the construction phase,

[16] https://ec.europa.eu/docsroom/documents/41261/attachments/1/translations/en/renditions/native

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sustainable site management and waste management skills are required. On the other hand, after construction, during the maintenance/renovation phase, it is crucial to develop technical and soft skills, with a focus on energy-efficient renovations and client communication; while the demolition phase requires skills in deconstruction, waste management and pollution detection, as well as managers who can provide strategic oversight.

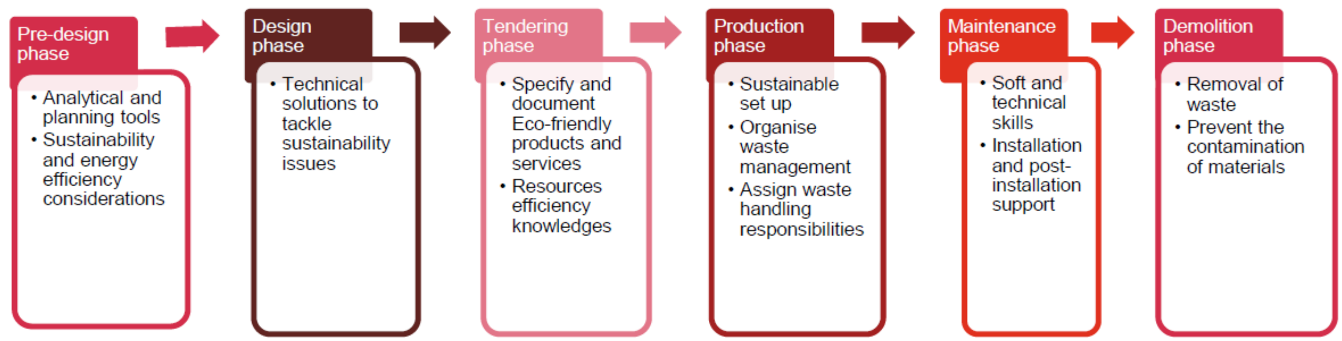

Figure 14: Skill needs across the construction process. Source: ECSO Improving the human capital basis, Analytical Report (2020)

The European Commission has also recognised and supported these efforts, both through its BUILD UP Skills initiative, which aims to equip construction professionals with the skills needed for the energy transition, and through other EU projects dealing with up-skilling and reskilling. One of these initiatives, the Blueprint Project in Construction,

3.3. Validation: Revision of National Documents

Largely due to the wide variation in content and specificity of the national documents reviewed by partners, the analysis cannot provide a definitive list of potential future skills. Not all countries have explicitly defined the skills they consider necessary to meet future needs, and the level of detail varies considerably.

Nevertheless, it is possible to identify certain skills and areas that are implicitly recognised as potential, and those existing skills that are expected to be in high demand (Figure 15). These include energy technologies and efficiency, which play a critical role in modern infrastructure; circular practices that focus on recycling and reuse for sustainability; sustainable construction practices, especially the use of environmentally friendly materials; Building Information Modelling (BIM) for efficient construction and facilities management; effective strategies for waste prevention, recovery and disposal; the installation and maintenance of advanced heating and cooling systems, including heat pumps and solar

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systems; building repair, modernisation and renovation; compliance and regulatory skills related to updated building codes and green certifications; the integration of digital technologies in various fields; and the adoption of low-carbon design, construction methods and materials.

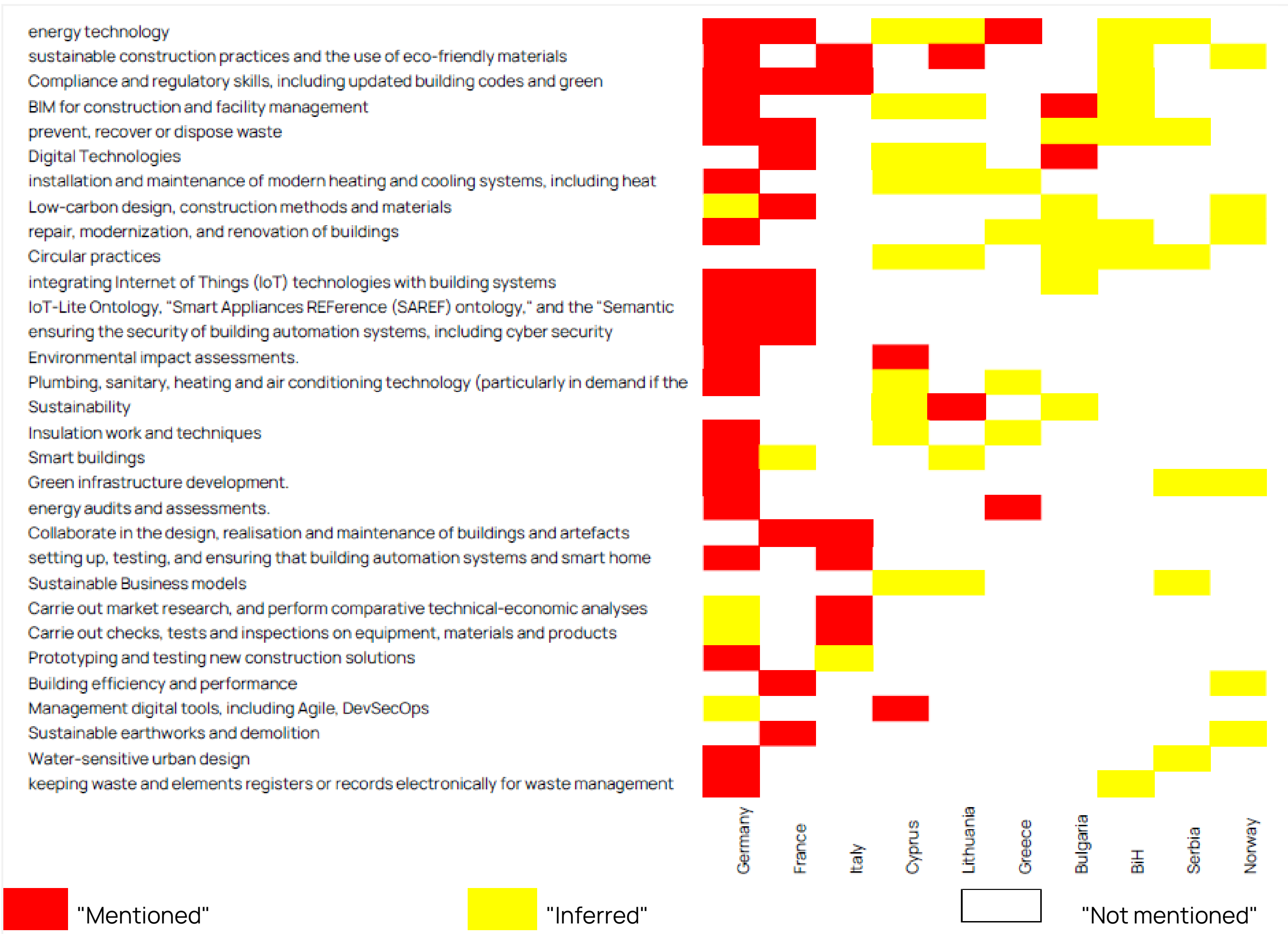

Figure 15: Mentions of potential future skills in National documents. Source: Own elaboration

Most of the skills identified in the analysis of national documents can be linked to four key topical areas: Zero carbon emissions in construction, circular economy practices, sustainable materials and sourcing, and collaboration and project management. The first three areas are closely aligned with the results of our survey, demonstrating a consistent understanding of their importance for future developments. However, the emphasis on Collaboration and Project Management, as highlighted for skills in the national documents, was not as pronounced in our survey results and was not explicitly defined as a key

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area of interest in the review of the national documents. The inclusion of Building Information Modelling (BIM) in the Collaboration and Project Management category may contribute to the observed discrepancy. However, our analysis suggests that BIM should be seen as an enabler across all areas, rather than being narrowly associated with management. The role of BIM as a comprehensive tool goes beyond mere project management; it facilitates the efficient planning, design, construction and operation of buildings, and thus intersects with most of the Topical areas.

3.4. Validation and prioritisation: Revision of Surveys

Through the analysis of the European Skills, Competences, Qualifications and Occupations (ESCO) framework, together with an in-depth review of relevant national documents and relevant information from the European Union, we formulated a set of Topical areas, Sub-areas and corresponding Skills and Knowledge considered crucial for the green and digital transitions (Table 2). This carefully list was then subjected to a validation process with our surveys. These surveys were strategically distributed to professionals and key stakeholders within the construction sector, as well as associated education partners and educational providers. The feedback received from these diverse groups played a key role in confirming the relevance and applicability of the proposed skills and knowledge areas, ensuring that they are aligned with current industry needs and future trends.

Table 2: Topical Areas, Subareas, Skills and Knowledge for the green and digital transition

Topical Area	Subarea	Skills and Knowledge descriptions
Net-Zero Carbon Emissions	Energy-efficient building design and technologies	Expertise in designing energy-efficient buildings
		Knowledge of green building materials and technologies
		Proficiency in using energy modelling software
		Skills in optimising HVAC (Heating, Ventilation, and Air Conditioning) systems for energy efficiency.
	Renewable Energy Technologies and Systems Integration	Knowledge of grid-tied and off-grid renewable energy systems.
		Understanding of integrating renewable energy sources such as solar panels and wind turbines into building designs,
	Smart Building Technologies	Proficiency in implementing smart building technologies for energy and resource management,
		Skills in integrating IoT (Internet of Things) devices for building automation.
	Environmental Impact Assessment	Competence in assessing the environmental impact of construction projects
		Knowledge of strategies to mitigate negative impacts

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		Compliance with environmental legislation, including Energy certifications and auditing
	Insulation	Insulation and finish systems installation (facades)
	General Environmental Awareness	
Circular Economy Practices	Circular economy principles and practices in construction	Ability to identify and implement circular business models in construction,
		Skill in creating value from the reuse and recycling of construction materials,
		Knowledge of economic aspects of circular construction.
	Materials Assessment and Selection	Skill in evaluating the environmental impact of construction materials,
		Knowledge of sustainable and recycled building materials,
		Ability to select materials with a low ecological footprint,
		Competency in conducting life cycle assessments of construction materials.
	Material flow management and waste reduction techniques	Expertise in managing material flows within construction projects
		Skill in tracking and optimising the use of resources,
		Knowledge of waste reduction and recycling techniques
		Competency in reusing materials on construction sites.
	Digital tools for circular construction	Proficiency in using Building Information Modelling (BIM) for resource optimization,
		Skill in digital tools that facilitate material tracking and reuse,
		Knowledge of construction software that supports circular design and construction.
	Design for Deconstruction	Ability to design buildings and structures for easy disassembly and reuse,
		Skill in creating modular and adaptable designs.
		Knowledge of techniques to minimise construction waste during deconstruction.
	Project Management for Circular Construction	Expertise in project management with a focus on circular principles,
		Skill in coordinating material reuse and recycling efforts,
		Competency in planning for deconstruction and future adaptability.
	Waste Reduction and Recycling	Competency in waste management and recycling practices on construction sites,
		Knowledge of recycling regulations and practices.
	Building renovation and retrofitting expertise	Data Analytics and Predictive Maintenance,
		Advanced Digital Modelling and Simulation
		Competence in conducting energy audits to assess building energy performance,

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Green Building Certification	Energy Auditing and Certification	Familiarity with green building certification programs like LEED (Leadership in Energy and Environmental Design) or BREEAM (Building Research Establishment Environmental Assessment Method).
	Green Building Codes and Regulations	Understanding of local and international green building codes and regulations,
		Ability to ensure compliance with these codes.
	Continuous Learning and Certification	Commitment to staying updated on the latest green building trends and technologies,
		Pursuit of relevant certifications like LEED Accredited Professional (or any other local Accreditation).
	Building Certification Programs	Familiarity with green building certification programs that emphasise occupant health and well-being, such as WELL or Fitwel,
		Skills in navigating the certification process and ensuring compliance.
Sustainable materials and sourcing	Materials Assessment and Selection	Skill in assessing the environmental impact of construction materials,
		Knowledge of sustainable and renewable material options,
		Expertise in selecting materials with lower carbon footprints,
		Ability to evaluate materials' life cycle analysis,
		Digital tools for comparing material sustainability data.
	Supply Chain Management	Skills in managing and optimising sustainable supply chains
		, Knowledge of responsible sourcing practices,
		Ability to track the origin and environmental credentials of construction materials,
		Utilising digital platforms for transparent and traceable supply chain management.
	Circular Economy Implementation	Understanding of circular economy principles for materials,
		Skills in reusing and repurposing construction materials,
		Knowledge of material recycling and upcycling techniques,
		Digital tools for tracking and managing material recycling processes.
	Green Label Certification	Expertise in obtaining and managing green building certifications,
		Knowledge of different certification standards (e.g., LEED, BREEAM),
		Ability to navigate digital platforms for certification applications and compliance.
	Digital Material Databases	Competence in using digital databases for sustainable material sourcing,
		Skills in accessing material information, including environmental impact data,
		Knowledge of digital tools to find local and sustainable material suppliers.
		Understanding of LCA methodologies, ,

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	Life Cycle Assessment (LCA)	Ability to conduct LCAs for construction projects
		Skills in using digital LCA software and tools.
	BIM (Building Information Modeling)	Proficiency in BIM for materials management, ,
		Knowledge of BIM's role in material sourcing and project sustainability
		Using BIM to optimise material quantities and reduce waste.
	Digital Procurement	Skills related to digital procurement processes, including online bidding and supply chain management, can lead to cost savings and efficiency improvements.
	Sustainable Procurement	Skills in sustainable procurement practices,
		Knowledge of green procurement standards,
		Utilising digital procurement platforms for sustainable material sourcing.
Occupant Health and Well-being	Health and Safety in Green Construction	Knowledge of health and safety regulations specific to green construction practices,
		Skills to ensure worker safety during sustainable construction projects.
	Indoor Environmental Quality (IEQ) Management	Skills to assess and improve indoor air quality
		Knowledge of ventilation systems and their impact on occupant health
		Expertise in controlling pollutants and maintaining comfortable temperature and humidity levels indoors,
		Understanding of the importance of natural lighting and ergonomic design in enhancing well-being.
	Occupant-Centric Design, engagement and Evaluation	Competence in designing spaces with occupant well-being in mind, such as ergonomic workspace design
		Knowledge of biophilic design principles that connect occupants with nature,
		Skills in selecting materials and finishes that are low in volatile organic compounds (VOCs) and allergens/
		Competency in conducting post-occupancy evaluations to assess the effectiveness of well-being measures,
		Skills to make necessary adjustments based on feedback and data.
		Skills to engage with building occupants to gather feedback on their comfort and well-being
		Ability to communicate with occupants regarding health and well-being practices.
	Health and Safety Protocols	Training in implementing health and safety procedures specific to construction sites, ensuring the well-being of workers and future occupants,
		Knowledge of safe construction practices and how they affect indoor environmental quality.
	Digital Health and Well-being Technologies	Familiarity with digital tools and sensors for monitoring and optimising indoor environmental quality.

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		Skills to integrate smart building technologies that enhance occupant comfort and well-being,
		Competency in data analysis to make improvements based on occupant feedback and sensor data.
	Inclusivity and Accessibility:	Expertise in designing buildings that are inclusive and accessible to all, including persons with disabilities,
		Knowledge of relevant building codes and regulations related to accessibility.
	Sustainable Interior Design:	Knowledge of sustainable interior design practices, including the selection of eco-friendly furnishings and finishes,
		Competency in creating spaces that promote well-being through color, texture, and layout choices.
	Smart Building Technologies	Skills to integrate smart building technologies that enhance occupant comfort and well-being,
Climate Resilience and Adaptation	Climate Risk Assessment:	assess the potential climate-related risks to construction projects, such as flooding, extreme heat, storms, and sea-level rise.
	Sustainable Site Design	design construction sites to be resilient to climate impacts, including drainage systems, elevation planning, and landscaping that can manage excess water and heat.
	Material Selection for Resilience	Knowledge of materials that can withstand extreme weather conditions, like wind-resistant roofing and flood-resistant building materials.
	Water Management:	Skills in sustainable water management, including rainwater harvesting, wastewater recycling, and the design of resilient water supply systems.
	Energy Efficiency and Climate Control	Expertise in designing energy-efficient and climate-controlled buildings to maintain comfort and safety during extreme weather events.
	Ecosystem Integration:	Understanding how to integrate natural ecosystems, like green roofs, urban forests, and wetlands, into construction projects to enhance resilience.
	Climate-Responsive Design:	create climate-responsive building designs that consider temperature regulation, natural lighting, and passive heating and cooling.
	Adaptive Infrastructure:	design adaptive infrastructure, such as movable flood barriers, stormwater detention basins, and flexible utility systems.
	Climate Modelling:	use climate modelling tools to predict local climate impacts and incorporate this data into construction plans.
	Emergency Response Planning:	Skills in developing emergency response plans to protect construction sites and workers during extreme weather events.
	Digital Tools and Data Analysis:	Proficiency in digital tools for data collection, analysis, and visualisation, enabling real-time monitoring of climate impacts.
	BIM (Building Information Modeling):.	Utilise BIM tools for better project coordination, simulation, and analysis to enhance climate resilience.
	Life Cycle Assessment (LCA):	Conduct LCAs to assess the environmental impact of construction projects and identify opportunities for improvement.

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	Community Resilience Planning:	Collaborate with local communities to develop climate resilience strategies that align with construction projects.
	Legal and Financial aspects	Understand the legal and financial aspects of climate resilience, including insurance, liability, and funding mechanisms.
Automation for Efficiency and Sufficiency	Data Analytics:	Provide insights into areas for efficiency improvement.
		Skills in data analytics, including data collection, interpretation, and visualisation, are becoming increasingly essential.
	Automation and Robotics:	Proficiency in operating and maintaining construction robots and automated machinery to enhance construction efficiency.
		Skills in robot programming and maintenance.
	IoT Integration:	Understanding and implementing the Internet of Things (IoT) in construction, such as sensors for real-time monitoring of equipment and structures
	Energy Management Systems:	Knowledge of energy management systems (EMS) and how to optimise building systems for energy efficiency
	Resource Management	Efficiently managing construction resources, including materials, labour, and equipment, requires skills in resource tracking and optimization using digital tools.
	Automated Building Systems:	skills related to automated building systems, such as smart HVAC and lighting controls
	Predictive Maintenance:	Understanding predictive maintenance techniques, which use data and sensors to predict when equipment will fail
	Digital Safety Protocols:	Implementing digital safety protocols and tools for real-time monitoring of safety conditions to enhance worker safety and compliance.
	Energy Modelling:	Proficiency in using energy modelling software to optimise building designs for energy efficiency and sustainability
	Advanced Simulation	Skills in using simulation software for testing and optimising construction processes and designs
	Lean Construction:	Knowledge on lean construction principles, which focus on eliminating waste and increasing efficiency
		Skills in lean construction methodologies
Collaboration and Project Management	Digital Construction Tools	Proficiency in Building Information Modeling (BIM) software,
		Skills in using construction project management software for efficient planning and communication.
	Data Analysis and Reporting	Ability to analyse building performance data and recommend improvements,
		Skills in generating sustainability reports for certification purposes.
	Digital Collaboration and Project Management	Skills in collaborative digital platforms for project management,
		Competency in virtual design and construction (VDC) methodologies.

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	Community Engagement and Advocacy	Ability to engage with local communities and stakeholders to promote sustainable construction practices,
		Skills in advocating for green building policies and initiatives.
	Sustainability Leadership:	Expertise in leading sustainability initiatives within construction organisations,
		Skill in driving cultural change towards circular and sustainable practices,
		Knowledge of sustainability certifications and standards.

Through this process we also derived significant insights regarding the most critical skills as perceived by our stakeholders and partners (Figures 16-20). This feedback has been instrumental in our analysis, allowing us to establish a clear prioritisation of skills. These prioritised skills are not only reflective of current industry needs but are also crucial for guiding the next phase of our project. By aligning our focus with the skills deemed most vital by our stakeholders and partners, we ensure that our project remains relevant and effectively addresses the evolving demands of the sector. These priorities are expressed in the final Matrix.

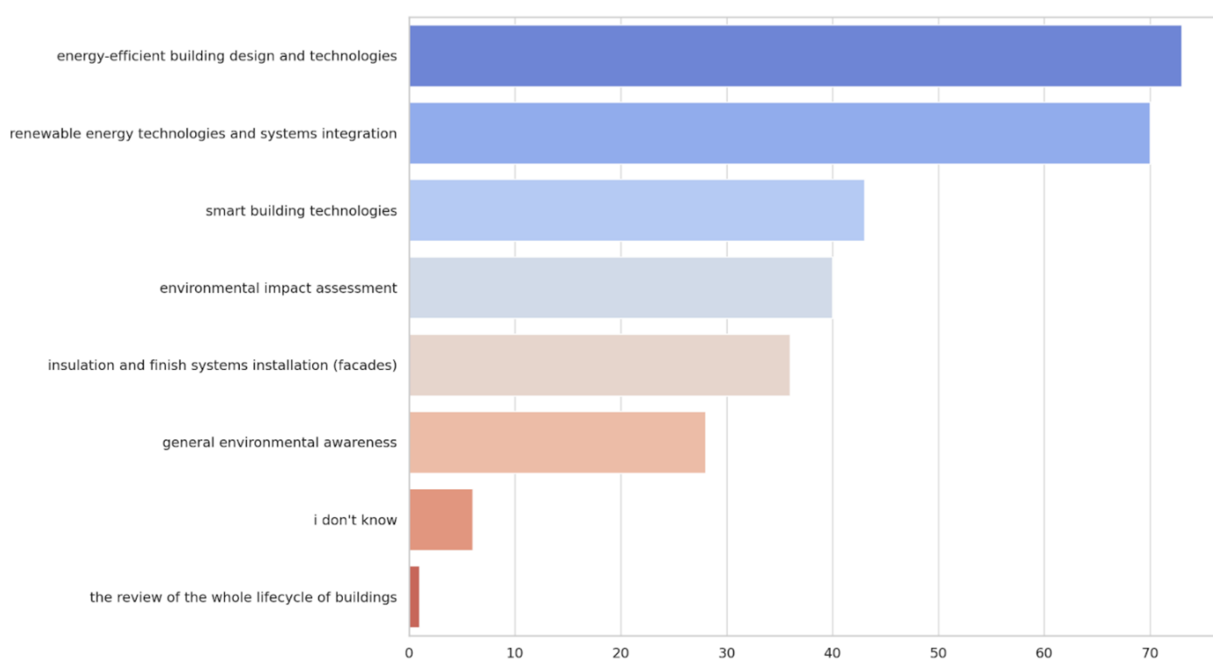

Figure 16: Survey 1, Net-Zero Carbon Emissions. Skills targeted as essential for the green and digital transition, grouped by Subareas. Source: Own elaboration

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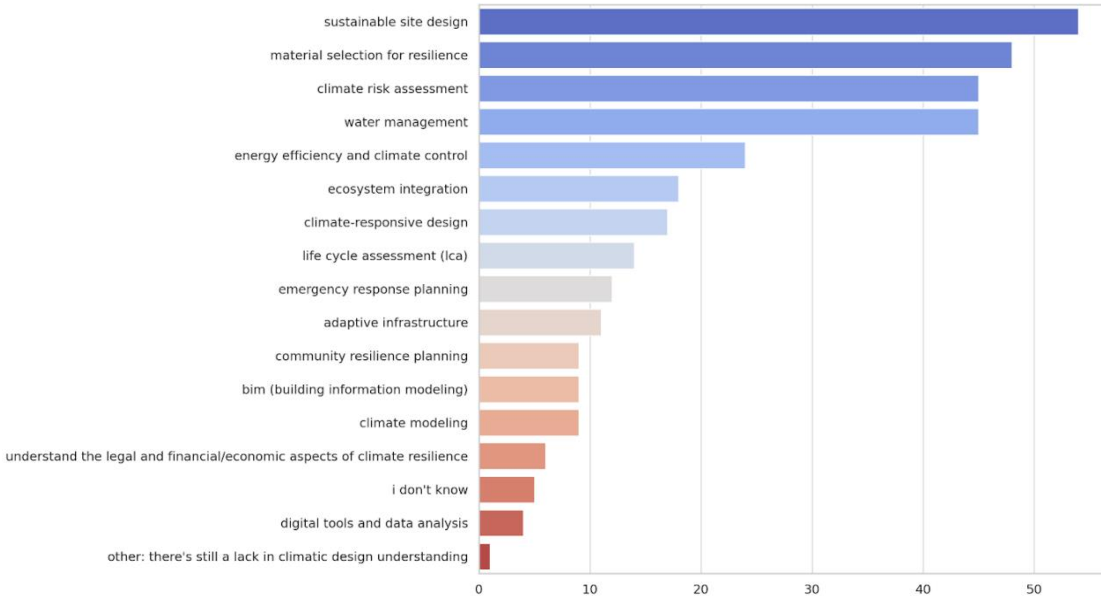

Figure 17: Survey 1, Climate Resilience and Adaptation. Skills targeted as essential for the green and digital transition, grouped by Subareas. Source: Own elaboration

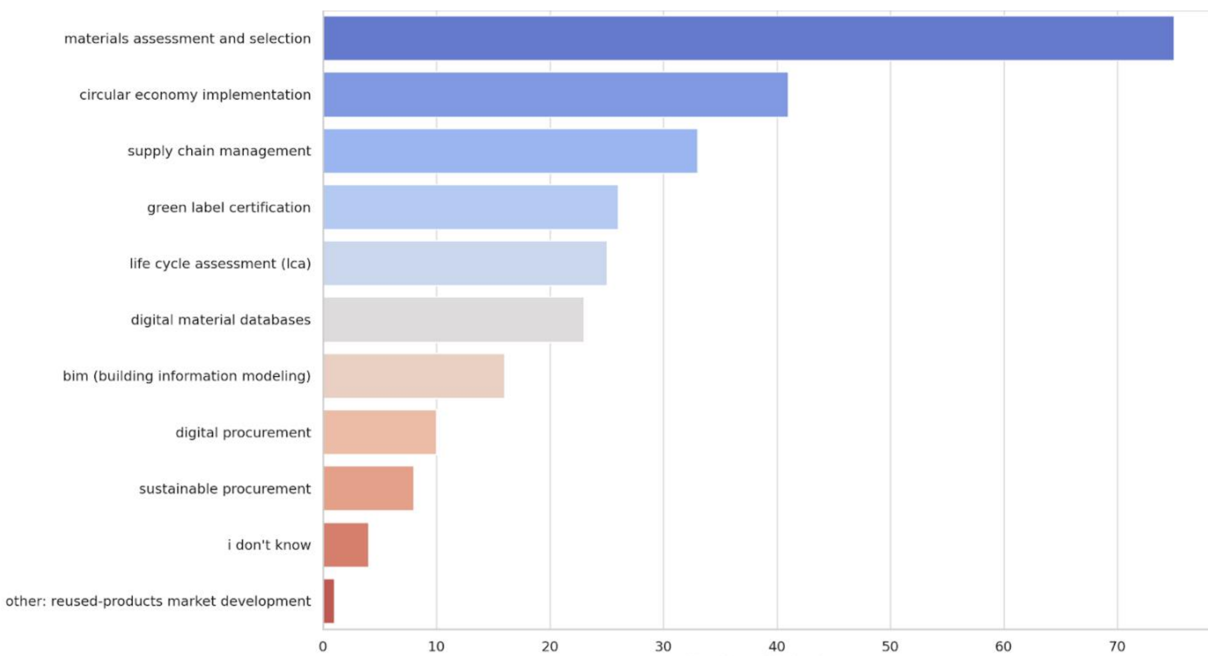

Figure 18: Survey 1, Sustainable Materials and Sourcing. Skills targeted as essential for the green and digital transition, grouped by Subareas. Source: Own elaboration

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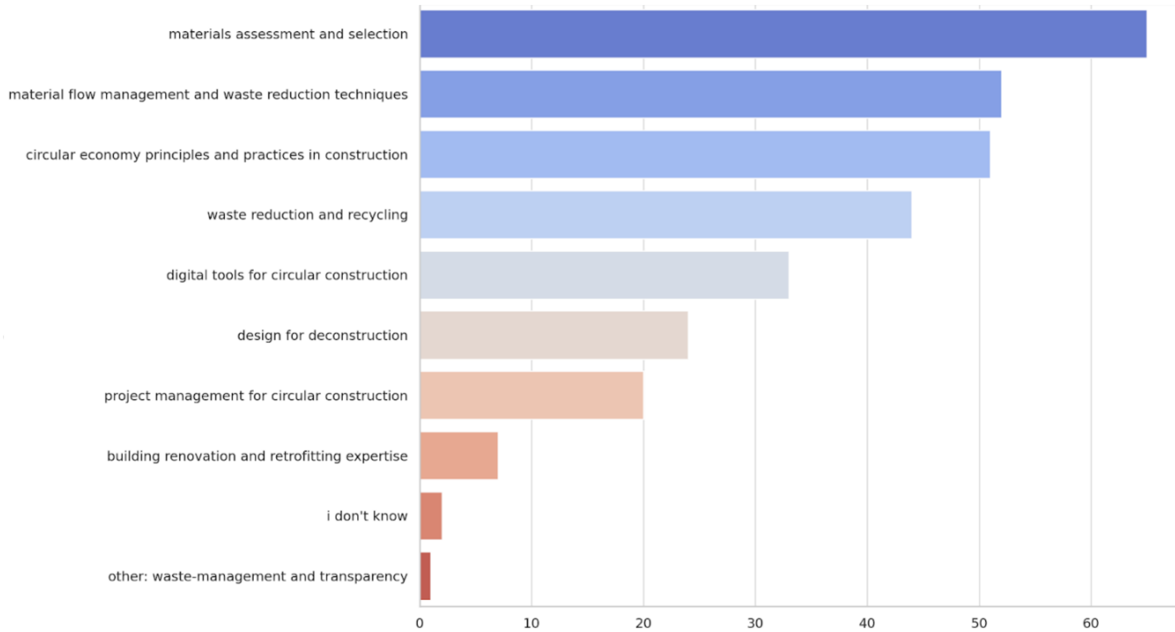

Figure 19: Survey 1, Circular Economy Practices. Skills targeted as essential for the green and digital transition, grouped by Subareas. Source: Own elaboration

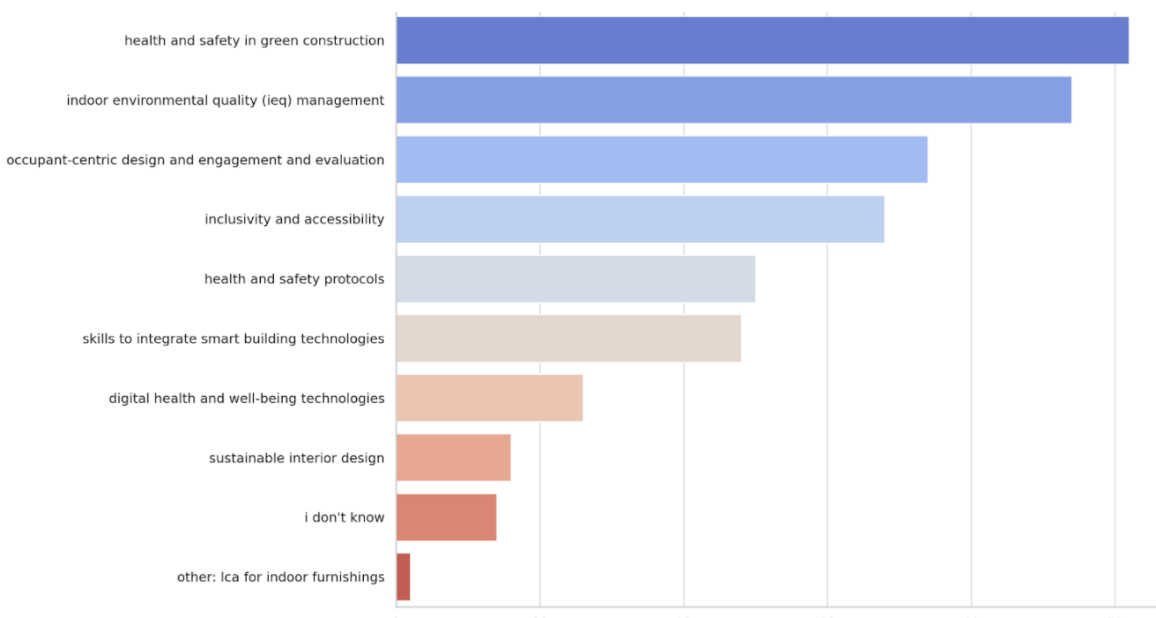

Figure 20: Survey 1, Occupant Health and Well-being. Skills targeted as essential for the green and digital transition, grouped by Subareas. Source: Own elaboration

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Skills Gap Matrix

The culmination of our work was the development of the Skill Gap Matrix[17], an integrated, comprehensive framework that synthesises our extensive research with the ESCO taxonomy. This tool effectively refines and expands the existing ESCO database to include a specific range of skills, knowledge, competencies and associated occupations. The Skill Gap Matrix is used to qualify and update the original database to ensure that it accurately reflects the current and emerging needs of the construction sector in order to address existing skills gaps and anticipate future labour market trends, thereby providing valuable guidance to educational and industry stakeholders.

In our efforts to integrate the results of our research on existing and proposed skills and knowledge, we undertook a detailed cross-referencing process with the previously established information from the European Skills, Competences, Qualifications and Occupations (ESCO) database. This step was carried out in collaboration with the ESCO team responsible for developing and updating the skills and occupations databases.

This integration took place in two stages. First, the ESCO team matched the data from our research - Topical areas, subareas and suggested skills - with ESCO's database of green and digital skills for our 38 selected occupations. This operation followed a three-step process: first, the ESCO skills were matched to the description of our sub-areas; second, these matches were then sorted based on their match scores. The match score is a quantitative measure that indicates the degree of relevance or alignment between the ESCO capabilities and our subarea description. Sorting by these scores facilitates the identification of the most relevant and closely aligned skills within each Topic Area. The final step in this process is an aggregation and sorting process. Once the detailed matching is complete, the data is aggregated by Topic Area. The result of this process is a comprehensive list of knowledge, skills and competences and the suggested Topical Areas and Sub-areas to which they might belong.

The second stage of our process involved a rigorous manual refinement of the results, with the following structured rules applied to ensure accuracy and relevance:

1. Elimination of unrelated or mismatched skills: We identified and removed skills that, although they matched in wording, did not match in meaning and purpose with the description of the sub-areas.

[17] Skills Gap Matrix Excel file link

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2. Review and pruning of repeated skills: We found that some skills were repeated across all sub-areas and areas. Each of these skills underwent a thorough review to determine their direct relevance to the specific sub-area. Skills deemed to be less relevant or irrelevant were then removed in order to focus on the most relevant skills.

3. Integration of missing skills: Through our research and analysis, we identified certain essential skills and knowledge areas that were not represented in the original ESCO database. These were then integrated into our matrix and labelled 'new' to ensure that our list was comprehensive and up to date.

4. Review and alignment across different areas: We found that certain skills, either in exact groups or in combinations, appeared in several areas. These were reviewed and their content standardised where necessary to ensure consistency and avoid duplication.

5. Combining complementary skills and sub-areas: Where skills were duplicated in sub-areas with overlapping or complementary functions, we merged these sub-areas. This approach helped to streamline the database and eliminate redundancies.

6. Inclusion of a Transitional Area: Based on our research and prior analysis, the sub-areas **Life Cycle Assessment (LCA), BIM (Building Information Modelling), Digital Tools and Data Analysis, Collaboration and Project Management** were integrated across all Topical areas.

Regarding the last point -the operational step of including a transition area- it is a critical operation that builds on the results of the extensive analysis conducted in the earlier stages and the insights gained from the previous five operational points.

Firstly, the previous analyses showed that these sub-areas emerged as key enablers of both the green and digital transitions. They were identified as cross-cutting issues that have a significant impact on different sectors and professions.

Secondly, in carrying out the first 5 operational steps, we found two characteristics that lead to this integration: a group of Topical areas explicitly included these sub-areas, including all skills and knowledge as part of them; while other Topical areas included most skills and knowledge individually or as part of other sub-areas, creating redundancy and repetition.

The Skills Gap Matrix final result, which correspond to the Excel file that accompanies this document, contains all the key components essential to our research:

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- An overview of the Topical Areas, broken down into sub-areas, including prioritised sub-areas and transitional areas.
- The Occupational Framework and Construction Cycle, which provides an overview of how our 38 selected occupations fit together.
- The skills gap matrix for our five topical areas: Climate Resilience and Adaptation, Net Zero Carbon Buildings, Circular Economy Practices, Sustainable Materials and Sourcing, and Occupant Health and Wellbeing.
- The ESCO list of green and digital skills, knowledge and competences for our selection of 38 occupations.

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