

chaise

blockchain skills for Europe

D3.2.1:

Annual Blockchain Skills Forecasts

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CHAISE Consortium			
Partner Number	Participant organisation name	Short name	Country
1	Université Claude Bernard Lyon 1	UCBL	FR
2	International Association of Trusted Blockchain Applications	INATBA	BE
3	Fujitsu Technology Solutions NV	FUJITSU	BE
4	Ministry of Education and Religious Affairs	YPEPTH	GR
5	ECQA GmbH	ECQA	AT
6	DIGITALEUROPE AISBL	DIGITALEUROPE	BE
7	IOTA Stiftung	IOTA	DE
8	Universitat Politècnica de Catalunya	UPC	ES
9	Duale Hochschule Baden-Württemberg	DHBW	DE
10	Associazione CIMEA	CIMEA	IT
11	INTRASOFT International S.A.	INTRASOFT	LU
12	Institute of the Republic of Slovenia for Vocational Education and Training	CPI	SI
13	European DIGITAL SME Alliance	DIGITAL SME	BE
14	University of Tartu	UT	EE
15	Univerza V Ljubljani	UL	SI
16	BerChain e.V.	BERCHAIN	DE
17	Italia4Blockchain	ITALIA4BLOCKCHAIN	IT
18	Autoritatea Națională pentru Calificări	ANC	RO
19	Akkreditierungs ,Certifizierungs- und Qualitätssicherungs- Institut e.V.	ACQUIN	DE
20	EXELIA	EXELIA	GR
21	INDUSTRIA Technology Ltd	INDUSTRIA	BG
22	Crypto4all	C4A	FR
23	Economic and Social Research Institute	ESRI	IE



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Abbreviations

AI	Artificial Intelligence
BC	Blockchain
CEDEFOP	(Translated) European Centre for the Development of Vocational Training
DLT	Distributed Ledger Technology
eIDAS	Electronic Identification and Trust Services
ESCO	European Skills, Competences, Qualifications and Occupations
EU	European Union
EU-LFS	European Union Labour Force Survey
EQF	European Qualifications Framework
E&T	Education and Training
ICT	Information and Communications Technology
ILO	International Labour Organization
ISCO	International Standard Classification of Occupations
IT	Information Technology
MiCA	Markets in Crypto-Assets Regulation
MOOC	Massive Open Online Courses
VET	Vocational Education and Training



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TABLE OF CONTENTS

ABBREVIATIONS	4
1 INTRODUCTION	9
2 METHODOLOGY	12
2.1 DATA.....	12
2.2 FORECASTING BLOCKCHAIN SKILLS DEMAND.....	12
2.3 FORECASTING BLOCKCHAIN SKILLS SUPPLY.....	20
2.4 DATA LIMITATIONS.....	20
3 RESULTS	22
3.1 OCCUPATIONAL FORECASTS.....	22
3.2 BLOCKCHAIN SKILLS DEMAND FORECAST.....	25
3.3 BLOCKCHAIN SKILLS SUPPLY.....	34
3.4 BLOCKCHAIN SKILLS SUPPLY FORECAST.....	36
3.5 COMPARING DEMAND AND SUPPLY FORECASTS.....	39
3.6 CONCLUSIONS.....	47
4 INTELLIGENCE GATHERING ACTIVITIES	49
4.1 SECTORAL DEVELOPMENT TRENDS.....	49
4.1.1 <i>Blockchain Regulatory and Policy Developments</i>	50
4.1.2 <i>Blockchain Education & Training Initiatives</i>	51
4.1.3 <i>Blockchain Ecosystem</i>	52
4.1.4 <i>Challenges and Opportunities</i>	52
4.2 CHANGES IN EDUCATION AND TRAINING PROVISION.....	53
4.2.1 <i>Primary Findings</i>	53
4.3 ECONOMIC AND POLICY DEVELOPMENTS.....	54
4.4 BLOCKCHAIN LABOUR MARKET DEVELOPMENTS.....	55
4.4.1 <i>Blockchain Job Vacancies</i>	56
4.4.2 <i>Blockchain Education and Training Offers</i>	57
4.4.3 <i>Blockchain Use Cases</i>	59
4.5 CONCLUSION TO INTELLIGENCE GATHERING ACTIVITIES.....	61
5 VERIFICATION OF RESULTS	63
5.1 INTERVIEWS OF NATIONAL BLOCKCHAIN EXPERTS.....	63



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5.1.1	<i>Methodology</i>	63
5.1.2	<i>Results</i>	64
5.1.3	<i>Skill Shortages & Policy Responses</i>	65
5.1.4	<i>Opportunities and Challenges</i>	66
5.2	BLOCKCHAIN SKILLS SURVEY ANALYSIS	67
5.2.1	<i>Forecasting Results</i>	67
5.2.2	<i>Skill Developments</i>	72
5.3	EXPERT ADVISORY BOARD FEEDBACK.....	74
5.4	CONCLUSION TO VERIFICATION OF RESULTS.....	74
6	CONCLUSIONS AND RECOMMENDATIONS	75
7	APPENDIX	78
7.1	JOB VACANCIES (INTELLIGENCE GATHERING ACTIVITIES)	78
	REFERENCES	79



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LIST OF TABLES

Table 1: Blockchain and Job Market Information from LinkedIn	16
Table 2: Forecasted Total Demand for Blockchain-Related ISCO Occupations by Country (2021-2025)	23
Table 3: Forecasted Blockchain Demand by Blockchain-Relevant ISCO Occupations, 2021-2025	27
Table 4: Forecasted Blockchain Demand by Blockchain-Relevant ISCO Occupations	29
Table 5: Proportion of Jobs in each ISCO Category that are Blockchain Jobs - EU-27	31
Table 6: Total ICT Graduates by EU-27 Country, 2015-2021 (Eurostat)	35
Table 7: Forecasted ICT and Blockchain Graduates by Country	37
Table 8: Forecast Summary for Demand and Supply, 2021-2026	40
Table 9: Comparing Forecasted Blockchain Skills Demand and Supply: 2021 - 2026	43
Table 10: E&T Offers by Certification Type	58
Table 11: E&T Offers by Field of Study	59
Table 12: Blockchain Use Cases by Sector	60
Table 13: Technical, Professional and Transversal Blockchain Skills (Survey Results)	73



LIST OF FIGURES

Figure 1 - Forecasting Blockchain Demand - Methodology 14

Figure 2 - Comparing Blockchain Skills Forecasting Results From 2021 to 2026 42

Figure 3 - Blockchain Skills Demand and Supply Forecasts 2021-2026, Eastern EU Countries 45

Figure 4 - Blockchain Skills Demand and Supply Forecasts 2021-2026: Peripheral EU Countries 46

Figure 5 - Blockchain Skills Demand and Supply Forecasts 2021-2026: Central EU Countries 46

Figure 6 - Blockchain Skills Demand and Supply Forecasts 2021-2026, Northern EU Countries..... 47

Figure 7 - Blockchain Use Cases by Application/Field..... 61

Figure 8 - Survey results from the mapping of blockchain jobs to occupational categories 68

Figure 9 - Survey results from demand forecasts 69

Figure 10 - Survey results from graduate demand forecasts 70

Figure 11 - Survey results from blockchain skills supply 71

Figure 12 - Survey results from supply forecasts 72



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1 Introduction

The diffusion of blockchain technology has brought about considerable changes to the European labour market. Blockchain is an advanced emerging technology, with marked variety in application and implementation. Blockchain and Distributed Ledger Technologies (DLTs) have been demonstrably implemented in banking, finance, ICT, education, healthcare, supply chain management and many other sectors. As adoption of blockchain technology continues to spread, the skill requirements for blockchain-related employment evolve, which has implications for blockchain education and training programmes and European skills policy. This report provides forecasting estimates for blockchain skills demand and supply in Europe between 2021 and 2026, highlighting key areas within the EU-27 where labour supply and demand asymmetries may arise. This report primarily serves as a tool to guide European policymakers in targeting digital skills programmes as they pertain to mitigating labour market asymmetries in blockchain skills.

For policymakers, information concerning the size of the blockchain labour market is key for informing policy goals. The blockchain labour market was estimated to equate to 361,767 workers in 2021, which was approximately 0.2% of European employment in the same year (McGuinness et al., 2023). However, given the rapid nature of blockchain technology's evolution and implementation, both the relative size and occupational composition of the blockchain labour market may have changed. This report is the third annual iteration of the CHAISE Blockchain Skills Forecasts and uses labour market data from 2023 to inform its forecasting estimates. A key advantage of producing repeated annual forecasts is that they may be dynamically updated with new labour market data, thereby providing up-to-date forecasting estimates. Furthermore, the report includes updated qualitative insights from blockchain stakeholders in Europe in 2023 to complement, validate and improve the accuracy of its quantitative findings.

This report contains information regarding occupational variation in blockchain skills demand in Europe. Key occupations that require blockchain skills are identified in collaboration with CHAISE Consortium members, which are updated on an annual basis. The occupational categories that emerged as key blockchain occupations in 2023 were:

- Software and Applications Developers and Analysts (ISCO 251)
- Database and Network Professionals (ISCO 252)
- Information and Communications Technology Services Managers (ISCO 133)



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- Business Services and Administration Managers (ISCO 121)
- Legal Professionals (ISCO 261)
- Sales, Marketing and Development Managers (ISCO 122)
- Finance Professionals (ISCO 241)
- Administration Professionals (ISCO 242)
- Sales, Marketing and Public Relations Professionals (ISCO 243)

In this year's report, four additional occupational categories were identified by CHAISE partners and implemented into the forecasting analysis that were not analysed in previous reports. This is done to reflect the evolving nature of blockchain skills requirements in Europe. The four additional occupations were ISCO 122, 241, 242 and 243.

The report also provides tentative evidence that current demand for blockchain skills has declined overall across Europe since 2021, reflected by the year-on-year reduction in the share of total vacancies posted on LinkedIn that require blockchain skills. In 2021, vacancies requiring blockchain skills accounted for 0.34% of all vacancies on LinkedIn in Europe, declining to 0.23% in 2023. This is reflected in the blockchain skills demand forecasting figures, which have been revised downward relative to the Year 2 CHAISE Blockchain Skills Forecasting estimates. Blockchain skills supply forecasts have also exhibited a downward revision relative to last year's report, though forecasted graduate supply figures remain sufficient to meet forecasted demand for graduates with blockchain skills on aggregate across Europe. Nevertheless, variation in symmetry between forecasted blockchain skills supply and demand at the graduate level persists between countries, with skills shortages being forecasted in some cases.

The report contains insights from blockchain stakeholders regarding sectoral, regulatory, educational and labour market developments and trends in the blockchain sector in 2023. Stakeholders report that skills shortages were a persistent limiting factor to the potential growth of the blockchain sector in 2023. While education and training experts from the CHAISE consortium observe that the number and variety of blockchain education and training offers has risen, stakeholders maintain that they are not sufficient to meet the needs of the European labour market.

In this year's report, we also conduct an analysis of a sample of blockchain applications and use cases collected by CHAISE partners in Europe. This is done to characterise the current iteration of blockchain



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technology and its associated implementation, providing information regarding how and where blockchain is being used in 2023 and how it may be used in the future. It is reported that blockchain technology application exhibits marked variety in both technical method and needs addressed, with the majority of use cases manifesting in the retail and accommodation and technology sectors in 2023.

Forecasting results were validated by 91 blockchain stakeholders in Europe via online survey and 45 blockchain field experts via interview. Broadly, survey respondents and interviewees agreed that the methodology and findings of the third year of forecasting were appropriate and generally accurate. Survey respondents also identified key technical, commercial and transversal skills for blockchain employers in 2023, highlighting the importance of a multidisciplinary skillset. Interview participants also provided their insight into challenges and opportunities facing the blockchain landscape in Europe.

Section 2 outlines the forecasting methodology used to provide estimates of blockchain skills demand and supply between 2021 and 2026. Section 3 contains the forecasting results, comparing forecasted blockchain skills demand and blockchain skills supply at the European and EU-27 country level. Section 4 contains the results of the intelligence gathering activities regarding sectoral, educational, regulatory and labour market developments in the EU in 2023. Section 5 details the process of validating the preliminary forecasting results for Year 3, in which the results of the online survey, field expert interviews and EAB meeting are summarised. Section 6 contains a discussion of the forecasting report for Year 3, outlining specific conclusions drawn from the results and recommendations for future research.



2 Methodology

In this section, we outline sources of blockchain-related data and procedures for forecasting blockchain skills demand and supply. We use data from a variety of sources, and we utilize a tailor-made data scraping tool to obtain important information about blockchain-related jobs. On the methods of blockchain skills forecasting, we use standard occupational forecasting approaches to estimate future demand for blockchain skills, and we apply linear trends to historic blockchain-related graduate information to estimate future supply of blockchain skills. The rest of this section provides more detail on sources of data, methods of data analysis, and limitations.

2.1 Data

The data used to forecast blockchain skills demand and supply comes from several sources. To forecast blockchain skills demand, information from online jobs advertisements, European Union Labour Force Survey (EU-LFS), and CEDEFOP occupational forecasts are employed. To forecast blockchain skills supply, Eurostat and national European government department/agencies are contacted to provide graduate data for each EU member state. The demand and supply of blockchain skills is forecasted for EU member states where data is available from 2021 to 2026. The methods of data analysis used in this study are based on the previous academic literature on forecasting employment and occupational outcomes. The data gathering process and methods of forecasting blockchain skills demand and supply are discussed below.

2.2 Forecasting Blockchain Skills Demand

Recent studies attempt to identify new and emerging occupations that are yet to be recognised in the current occupational classification framework. A notable example is ILO (2020), in which AI algorithms are used to incorporate language that characterises occupations based on word-embeddings in job vacancies to understand the developments of emerging technologies and their placement in the current occupational framework. CEDEFOP (2018) have also utilised a similar approach to map important real-time labour market information about the current job market to specific occupational categories. Mezzanzanica and Mercurio (2019) state that specific word terms that link occupations to online job vacancies also link to the skills that are important in those occupations. In this way, it is possible to



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accurately map the current online jobs market information to occupational classification frameworks and identify the necessary skills.

We build on the approaches set out by ILO (2020), Mezzanzanica and Mercorio (2019), and CEDEFOP (2018) to map current blockchain related jobs advertised to the ISCO occupational classifications. However, when forecasting the demand for skills it is important to incorporate macroeconomic developments and employment projections in the changing dynamic of skills demand in various occupations (McGuinness et al., 2012). CEDEFOP employment and occupational forecasts capture skills needs, economic factors and developments in the future (Biagi et al., 2020). Therefore, we also incorporate CEDEFOP employment and occupational forecasts to account for different macroeconomic and labour market developments when forecasting blockchain skills demand.



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The methodology for forecasting blockchain skill demand is summarized in Figure 1 below.

Step 1: Collecting blockchain-related vacancy data

- A unique tailored scraping tool is used to collect information on blockchain jobs advertised
- LinkedIn job advertisements are scraped using "blockchain" as a keyword (in job title or job description) to identify blockchain-related jobs

Step 2: Mapping blockchain-related jobs to ISCO classification

- Use appropriate keywords to map blockchain-related jobs to ISCO categories
- The core blockchain-related occupational categories are identified
- Use EU-LFS data to derive 3-digit ISCO categories from 2-digit ISCO categories where necessary

Step 3: Estimate the share of blockchain-related jobs in each ISCO classification

- The share of blockchain-related jobs as a proportion of total jobs are estimated for ISCO category
- LinkedIn job advertisements are used to estimate the proportion of each ISCO category that was blockchain-specific by identifying the percentage of each core blockchain-related occupational category, for example 'Software and Applications Developers and Analysts'

Step 4: Forecasting the demand for blockchain skills in each ISCO classification

- The share of blockchain jobs in each ISCO category is applied to the CEDEFOP forecasts to estimate the number of new blockchain jobs for each European country between 2021 and 2025
- The headline results are augmented with a multiplier to account for forecasting for one additional year (2026)
- The share of blockchain jobs advertised at an entry level or graduate level is identified to determine the proportion of demand that is graduate demand

Figure 1 - Forecasting Blockchain Demand - Methodology

One challenge in forecasting demand for blockchain skills is that only recently blockchain specific job categories have been added to the existing occupation taxonomies. For the purposes of this report, appropriate information on blockchain occupations from external sources is still lacking. Therefore, to forecast blockchain skills demand we utilised an approach set out in CEDEFOP (2018) to map blockchain related job advertisements to the International Standard Classification of Occupations (ISCO). The mapping of blockchain related job advertisements to ISCO categories provided a sample of blockchain skills demand for forecasting analysis. In *Step 1*, the data on blockchain jobs was collected by employing a purpose made automated online job scraping software to extract online jobs information



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from a popular job advertisement website. The approach is similar to CEDEFOP (2018), who also used a web scraping technology to extract online jobs information.

After consulting a variety of popular job advertisement sites around Europe, LinkedIn was identified as the most reliable source for blockchain related jobs data, as it consistently produced high numbers of blockchain jobs across all European countries¹. LinkedIn is also the world's largest and most developed professional network. Unlike other job advertisement sites considered, it also provided us with the seniority level for each job to derive valuable information on entry level or graduate jobs. We also believe that blockchain employment is largely in professional occupations and that LinkedIn is suited very well for professional jobs advertisements. Furthermore, our consideration of job advertisement sites and the source of data has been reviewed by the CHAISE consortium and over 40 external blockchain sector experts (during six virtual expert consultations held by the ESRI) who agreed that LinkedIn is the most appropriate data gathering source for blockchain jobs.

To contextualise the size of the blockchain labour market in Europe, Table 1 shows a sample of blockchain related and total jobs advertised on LinkedIn in November of 2021, 2022 and 2023, and the proportion of total jobs that are blockchain related jobs for each EU member state. The table approximates the size of the blockchain labour market and the demand for blockchain skills across the three years of forecasting (2021, 2022 and 2023).² The blockchain market has declined from approximately 0.34% of all LinkedIn jobs (2021) to approximately 0.23% in 2023.

¹ While it is recognised that LinkedIn job advertisements may not be representative of the entire European labour market, the consortium, and expert partners, assume that it provides an adequate representation of current blockchain jobs at a country level within the EU, or at least the most adequate information that exists.

² Since these data were collected at specific points in time (i.e. November of each year), and do not explicitly capture all vacancies published throughout the reference period, this approximation comes with the caveat that figures are subject to time-specific factors.



Table 1: Blockchain and Job Market Information from LinkedIn

Country	2021 Jobs			2022 Jobs			2023 Jobs		
	Blockchain Jobs (LinkedIn)	Total Jobs (LinkedIn)	% of Total Jobs	Blockchain Jobs (LinkedIn)	Total Jobs (LinkedIn)	% of Total Jobs	Blockchain Jobs (LinkedIn)	Total Jobs (LinkedIn)	% of Total Jobs
Austria	142	37,203	0.38%	72	47,898	0.15%	77	42,712	0.18%
Belgium	216	63,217	0.34%	132	87,578	0.15%	118	76,027	0.16%
Bulgaria	350	8,171	4.28%	69	6,775	1.02%	112	4,799	2.33%
Croatia	102	2,298	4.44%	43	2,175	1.98%	26	1,816	1.43%
Cyprus	50	1,279	3.91%	23	1,903	1.21%	15	1,477	1.02%
Czechia	197	36,852	0.53%	44	34,389	0.13%	32	28,284	0.11%
Denmark	155	15,357	1.01%	35	16,169	0.22%	41	12,033	0.34%
Estonia	53	2,081	2.55%	43	2,109	2.04%	41	1,238	3.31%
Finland	86	8,910	0.97%	22	10,673	0.21%	8	5,998	0.13%
France	1,088	697,752	0.16%	1,587	949,096	0.17%	1,115	796,075	0.14%
Germany	2,624	1,007,673	0.26%	2,249	1,033,475	0.22%	1,713	775,157	0.22%
Greece	85	6,607	1.29%	46	9,746	0.47%	42	8,611	0.49%
Hungary	261	14,277	1.83%	66	13,865	0.48%	54	10,626	0.51%
Ireland	352	38,246	0.92%	244	35,815	0.68%	150	25,952	0.58%
Italy	650	173,254	0.38%	577	147,610	0.39%	500	105,139	0.48%
Latvia	14	1,588	0.88%	11	1,783	0.62%	11	1,219	0.90%
Lithuania	65	4,093	1.59%	41	4,366	0.94%	59	3,293	1.79%
Luxembourg	109	6,571	1.66%	52	7,947	0.65%	102	6,363	1.60%
Netherlands	731	475,026	0.15%	433	335,930	0.13%	264	357,261	0.07%
Poland	1,111	112,459	0.99%	427	101,907	0.42%	377	73,632	0.51%
Portugal	277	66,868	0.41%	139	26,664	0.52%	112	21,309	0.53%
Romania	647	24,871	2.60%	377	25,930	1.45%	210	16,463	1.28%
Slovakia	158	3,875	4.08%	158	5,008	3.15%	92	3,577	2.57%
Slovenia	22	1,292	1.70%	27	1,230	2.20%	18	1,010	1.78%
Spain	585	64,093	0.91%	564	96,319	0.59%	480	82,304	0.58%
Sweden	132	52,376	0.25%	46	97,906	0.05%	51	61,090	0.08%
Total	10,262	2,926,289	0.35%	7,522	3,104,266	0.24%	5,820	2,523,465	0.23%

Note: Data for all three years was collected from LinkedIn in November of the respective year to ensure comparability across time.



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The search criteria on LinkedIn are based on the keyword “blockchain” appearing in the job title and/or the detailed job advertisement. LinkedIn online jobs advertisements were scraped for each of the EU-27 countries. These jobs are classified as blockchain-related jobs. Then, in *Step 2*, blockchain related jobs are translated into occupations (ISCO) based on the job title, job description, and keywords. Important ISCO categories and keywords used to link blockchain jobs to specific ISCO occupations were verified by CHAISE partners.³ Further, each CHAISE partner reviewed the mapping of blockchain jobs to ISCO categories for their home country for robustness. Post-partner review, the sample of scraped job advertisements totalled to 3,335 across the EU-27 countries. Across the EU member states, the following 3-digit ISCO categories emerged as the key occupations in blockchain:

1. Software and Applications Developers and Analysts (ISCO 251)
2. Database and Network Professionals (ISCO 252)
3. Information and Communications Technology Services Managers (ISCO 133)
4. Business Services and Administration Managers (ISCO 121)
5. Finance Professionals (ISCO 241)
6. Sales, Marketing and Public Relations Professionals (ISCO 243)
7. Sales, Marketing and Development Managers (ISCO 122)
8. Administration Professionals (ISCO 242)
9. Legal Professionals (ISCO 261)

It should be noted that ISCO 122, 241, 242 and 243 were not included in previous CHAISE Blockchain Skills Forecasting reports. These categories were added in the third year on request from CHAISE Consortium members and consortium management to provide a more granular analysis of blockchain skills demand by industry, and to improve the accuracy of vacancy categorisation by occupation.

Approximately 93% of all blockchain related jobs were mapped to one of the ISCO categories identified above. The remaining 7% of blockchain related jobs were represented by the ‘other’ category since their

³ Keywords and mapping criteria available on request. Consultations were held with the following CHAISE partners: INTRASOFT, C4A, IOTA, FUJITSU.



overall representation by a specific ISCO was relatively insignificant. However, all blockchain jobs, including 'other', were used in the forecasting analysis.

We utilised CEDEFOP occupational forecasts for each European member state to identify, in absolute terms, by how much employment in each blockchain related ISCO category is likely to change from 2021 to 2026. Since CEDEFOP occupational forecasts incorporate important information on future employment, education, and labour force trends, as well as European and global economic developments, they are a valuable source of data to forecast blockchain labour market trends in Europe. Similarly, Biagi et al. (2020) have previously utilised CEDEFOP employment forecasts in their labour market analysis.

In 2023, CEDEFOP updated its skills forecasting methodology, changing the employment forecasting period from 2021 to 2026 to 2021 to 2025. To maintain consistency across CHAISE Blockchain Skills Forecast reports, we estimated blockchain skills demand for 2021 to 2025 using the same skills demand forecasting methodology as previous years, and augmented these estimates by assuming that CEDEFOP annual employment growth rates would remain constant for one additional year (i.e. 2026).

CEDEFOP occupational forecasts are available at 2-digit ISCO level. However, this study examines demand for blockchain skills at a 3-digit ISCO level. In order to apply CEDEFOP forecasts to our data the EU Labour Force Survey 2021 data was used for each country to derive 3-digit ISCO proportions from the 2-digit ISCO categories and apply them to the CEDEFOP forecasts. The results identified the proportion of CEDEFOP occupational forecasts in each of the blockchain related occupations at a 3-digit ISCO level.

Furthermore, we must also consider that not every job within an ISCO 3-digit classification relates to blockchain. In *Step 3*, to identify the proportion of each ISCO category that is a blockchain job, it was necessary to estimate the percentage of each of the listed 3-digit occupations advertised on LinkedIn that are blockchain jobs. Thus, for each of these key 3-digit occupations identified, we estimated the share of blockchain-related jobs as a proportion of total jobs for each occupation using LinkedIn data. It is important to note that LinkedIn search output may yield different results if inverted commas are used



around the keywords. Inverted commas around the search term will yield results related to the specific search criteria, while search results with no inverted commas produces all jobs related to the search criteria, which may or may not encompass the searched keyword in the job title or description. Further tests indicated that a more accurate representation of jobs in each occupational category may be achieved without using inverted commas in LinkedIn job search and was applied in the analysis.

To forecast blockchain skills demand between 2021 and 2026 across Europe, the percentage of blockchain jobs in each ISCO category was applied to the CEDEFOP 2021-2025 occupational employment forecasts at the 3-digit ISCO level to estimate the number of new blockchain jobs for each country. To account for one additional year (i.e. 2026) and maintain consistency with previous reports, a multiplier was applied to augment the total forecasted demand figures.⁴

Although most blockchain jobs fall into one of the nine ISCO categories identified previously, some jobs were not allocated to these nine specific ISCO categories. These jobs were classified as 'other'. We incorporated these 'other' jobs in the final forecasting model to obtain a more accurate estimation by inflating our forecasts by the appropriate percentage for each country. In *Step 4*, from the scraping of online jobs advertisements, we were also able to identify the proportion of all blockchain jobs that were advertised at an entry level or graduate level. The proportion of blockchain jobs classified as 'entry or graduate' level ranged from 25% in Malta to 64% in Romania, with the overall sample proportion being approximately 43%.⁵ This enabled us to estimate the proportion of total forecasted blockchain jobs that may be at the graduate level. The final blockchain skills demand forecasts are presented for each European country for which relevant data was available and at specific occupational categories.

⁴ This multiplier was calibrated such that the additional year's forecasted growth in blockchain vacancies was equivalent to the average one-year vacancy growth of the previous four years, which is mathematically equal to an additional 25% of the total 2021-2025 vacancies.

⁵ Entry level positions were estimated as all jobs which stated 'entry level' in the job advert posting on LinkedIn and 75% of those positions who either did not specify the education level i.e. 'not applicable' or where the information was missing. Please see Table 8, Column 3 and a more detailed table can be provided on request from the authors.



2.3 Forecasting Blockchain Skills Supply

Blockchain skills supply is estimated by identifying the number of graduates with some blockchain exposure in higher education courses. However, accurate and reliable information on the number of graduates with blockchain skills is not available across Europe. Therefore, this study utilises graduate data from blockchain related fields of study to forecast blockchain skills supply from 2021 to 2026 for EU-27 member states. CHAISE partner input and information from Eurostat was used to produce estimates for new labour market entrants from blockchain related Education and Training (E&T) programmes. From expert consultations and CHAISE partner feedback, the Information and Communication Technology (ICT) field contained the most blockchain relevant degree programmes. Therefore, we forecast ICT graduates from 2021 to 2026 for each member state using linear trends based on data sourced from 2015 to 2021 on ICT graduates.

A sample of CHAISE partners supplied estimates of graduates with at least some exposure to blockchain learning for their home countries (Austria, Belgium, Estonia, France, Germany, Ireland, Italy, Slovenia, and Spain) most completely for 2021. This allowed for an estimation of the share of blockchain graduates as a share of total ICT graduates for these countries in this year, which ranged from the lowest in Austria (0.42%) to the highest in Belgium (5.74%). The average of these estimates of blockchain graduates was 2.49% and was used to estimate the number of graduates with blockchain exposure for all other countries for which blockchain graduate data was unavailable. These supply-side forecasts provide a framework that will also allow individual member states to estimate blockchain skills supply based on their understanding of their country's education system.

2.4 Data Limitations

Although this study utilised a unique method of forecasting blockchain skills supply and demand, it encountered data issues that need to be acknowledged. For blockchain skills demand, data comes from online job vacancies advertised on LinkedIn. In general, online job vacancies suffer from the following limitations: they are a sample of total jobs demand as not all jobs are advertised on LinkedIn; across Europe there are different methods of advertising jobs, and there are many different online job vacancy providers; information contained within job advertisements may differ depending on occupational requirements and employer demands. Next, the mapping of blockchain jobs to ISCO categories involves a mixture of automated and manual mapping processes based on keywords that may misallocate some



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jobs to different ISCO categories. Detailed analysis of online job vacancies is inherently subject to human or systematic errors even when most up-to-date data technique are used (CEDEFOP, 2019). It is also important to acknowledge that missing CEDEFOP forecasts and EU-LFS occupational data for a small number of countries means that such forecasts rely on additional assumptions and estimates (further documented in footnotes on Table 4).

In terms of blockchain skills supply, unavailable information on the number of blockchain specific graduates for most EU countries means that blockchain supply forecasts for countries that are missing this information are based on average EU estimates of blockchain graduates rather than country specific data. Further, due to the lack of EU-wide information on the number of graduates from blockchain courses, we estimate the number of graduates with some blockchain exposure through modules or classes in the forecasting analysis. Unlike demand side forecasts, supply forecasts do not incorporate macroeconomic and demographic changes in their projections. Supply side forecasts do not specifically consider blockchain skills supply from vocational education and training providers, due to the lack of data availability across the EU-27 countries. However, VET experts are interviewed as part of skills intelligence gathering activities (see Section 4) and the forecasting results validation process to provide further input on blockchain skills supply.

This is our third attempt to document both the measurement and forecasting of blockchain skills demand and supply in Europe. The resulting forecasts will facilitate the EU, and individual member states, in reviewing and assessing the extent to which labour market imbalances are likely to occur in the short-term that could inhibit the development of the blockchain sector. In particular, the results of the study will inform the development of a more strategic approach to the delivery of a blockchain skills strategy that will help future proof the sector against forms of skills mismatch.

Having outlined the sources of data, methods of data analysis and limitations associated with forecasting blockchain skills demand and supply, we present the key forecasting results from in the next section.



3 Results

In this section we present the key results on forecasting blockchain skills demand and supply. We begin by presenting CEDEFOP occupational forecasts, followed by blockchain skills demand forecasts, historic data on blockchain-related graduate supply, and finally blockchain skills supply forecasts from 2021 to 2026. In this section we focus on the latest forecasting results using data from 2023, but we also refer to forecasting results from the previous two years of forecasting activities, which used blockchain-related information from 2021 and 2022. We make comparisons to previous years of forecasting to identify any changes in the current blockchain labour market between forecasting results.

3.1 Occupational Forecasts

Blockchain skills demand forecasts are based on CEDEFOP occupational forecasts presented in Table 2. The five key 2-digit ISCO categories containing the most blockchain jobs are *Information and Communications Technology Professionals* (ISCO 25), *Production and Specialised Services Managers* (ISCO 13), *Administrative and Commercial Managers* (ISCO 12), *Business and Administration Professionals* (ISCO 24) and *Legal, Social and Cultural Professionals* (ISCO 26). CEDEFOP's 2-digit ISCO forecasts indicate the change in employment in each occupational category for each of EU-27 member states from 2021 to 2025. Absolute change in the numbers of persons employed in these occupations is utilised in the blockchain skills forecasting.



Table 2: Forecasted Total Demand for Blockchain-Related ISCO Occupations by Country (2021-2025)

	Administrative and Commercial Managers		Production and Specialized Service Managers		Business and Administration Professionals		Information and Communications Technology Professionals		Legal, Social and Cultural Professionals	
	(ISCO 12)		(ISCO 13)		(ISCO 24)		(ISCO 25)		(ISCO 26)	
	(CEDEFOP Annual Rate)	(#)	(CEDEFOP Annual Rate)	(#)	(CEDEFOP Annual Rate)	(#)	(CEDEFOP Annual Rate)	(#)	(CEDEFOP Annual Rate)	(#)
Austria	1.20%	4,191	-0.3%	-949	-0.1%	-684	1.3%	5,117	1.1%	5,719
Belgium	1.80%	11,768	0.9%	4,711	2.2%	18,967	3.4%	19,749	2.8%	24,011
Bulgaria	0.90%	1,427	-2.0%	-5,459	-0.1%	-604	1.7%	4,204	0.7%	2,619
Croatia	1.80%	1,117	-0.2%	-242	1.9%	3,385	3.2%	3,722	1.7%	4,831
Cyprus	1.80%	370	4.1%	1,514	1.1%	625	3.5%	913	1.9%	1,064
Czechia	0.30%	745	-1.2%	-4,533	3.3%	24,187	5.8%	30,025	1.8%	10,045
Denmark	2.10%	2,108	3.0%	4,152	1.9%	13,577	3.7%	13,715	2.3%	9,176
Estonia	2.80%	1,479	1.2%	1,828	0.3%	348	3.6%	2,865	2.0%	1,456
Finland	-1.10%	-834	-0.1%	-111	1.9%	12,942	1.6%	6,735	1.4%	5,660
France	-1.50%	-39,782	2.7%	138,562	1.8%	96,238	2.7%	65,570	0.9%	28,964
Germany	0.70%	16,179	-0.9%	-16,742	0.7%	47,680	0.9%	34,796	0.8%	45,129
Greece	-2.40%	-2,041	-0.5%	-759	0.1%	603	2.8%	4,313	1.0%	5,700
Hungary	-3.00%	-3,500	0.3%	986	0.6%	3,414	1.5%	5,651	0.8%	4,518
Ireland	4.60%	9,046	4.1%	12,163	3.0%	18,877	2.7%	8,026	2.0%	4,355
Italy	-0.30%	-494	-0.4%	-4,523	2.4%	64,065	1.6%	15,296	1.8%	44,901
Latvia	0.50%	373	-0.1%	-116	0.6%	1,037	2.5%	1,741	2.2%	1,916
Lithuania	0.20%	316	-2.5%	-3,716	0.5%	2,203	3.1%	3,461	1.2%	2,031



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Table 2: Forecasted Total Demand for Blockchain-Related ISCO Occupations by Country (2021-2025)

	Administrative and Commercial Managers		Production and Specialized Service Managers		Business and Administration Professionals		Information and Communications Technology Professionals		Legal, Social and Cultural Professionals	
	(ISCO 12)		(ISCO 13)		(ISCO 24)		(ISCO 25)		(ISCO 26)	
	(CEDEFOP Annual Rate)	(#)	(CEDEFOP Annual Rate)	(#)	(CEDEFOP Annual Rate)	(#)	(CEDEFOP Annual Rate)	(#)	(CEDEFOP Annual Rate)	(#)
Luxembourg	1.10%	253	2.0%	271	3.4%	11,645	3.3%	2,687	3.6%	6,063
Malta	-0.40%	-128	1.7%	497	1.6%	623	3.4%	639	2.3%	737
Netherlands	-1.60%	-7,783	-0.9%	-5,738	1.6%	53,185	1.8%	27,629	1.6%	29,022
Poland	1.60%	16,856	-2.3%	-28,383	2.3%	87,505	2.8%	36,445	1.0%	16,249
Portugal	1.60%	3,211	-0.6%	-2,705	2.0%	14,703	5.1%	20,045	2.4%	13,434
Romania	3.50%	4,824	-0.8%	-1,792	5.7%	72,530	4.6%	18,008	4.5%	41,537
Slovakia	3.10%	3,768	1.3%	3,129	1.3%	2,635	3.8%	6,498	-0.4%	-935
Slovenia	0.60%	505	-0.4%	-543	1.5%	3,369	2.4%	2,176	1.2%	1,906
Spain	1.10%	9,129	-0.9%	-9,549	2.0%	41,646	3.0%	27,729	0.9%	23,559
Sweden	0.50%	2,312	2.9%	17,358	3.0%	41,812	1.9%	16,375	2.7%	25,014

Notes: Annual percentage change and absolute numbers in 2-digit ISCO categories were derived from CEDEFOP occupational forecasts from 2021 to 2025, available at <https://www.cedefop.europa.eu/en/tools/skills-forecast>.



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3.2 Blockchain Skills Demand Forecast

In Tables 3 and 4, blockchain skills demand forecasts are presented for EU-27 countries. For each of the key blockchain related occupations, total demand represents the change in employment in a specific occupation over the period 2021 to 2025. Blockchain demand reflects the size of an occupational change that is likely to be blockchain specific. The demand for blockchain skills for each country depends on the proportion of blockchain jobs in a specific occupational category in that country. Therefore, greater proportion of blockchain jobs in a specific occupational category means that the demand for blockchain skills will change by a more substantial amount. This also explains disparities in blockchain skills demand between different countries. For example, although France and Germany are similar in population size, relative to the rest of Europe, their forecasted additional blockchain jobs differ significantly, with 1,195 new blockchain jobs forecasted in France and only 691 new blockchain jobs in Germany. The main reason for this is a relatively greater proportion of blockchain jobs in *Business Services and Administration Managers, Sales, Marketing and Development Managers* and *Information and Communications Technology Service Managers* occupations in France than in Germany. Therefore, more additional blockchain jobs are forecasted in France than in Germany. The proportion of blockchain jobs to specific ISCO categories for each country are presented in Table 5 (overleaf).

In some EU-27 countries, a reduction in blockchain demand for specific occupations is forecasted. This is based on CEDEFOP occupational forecasts, which predict that net employment growth will be negative between 2021 and 2025 in specific occupations within certain countries. For example, a decline of 2,009 vacancies in *Information and Communications Technology Services Managers* (ISCO 251) is predicted for Germany, which equates to a decline of 22 blockchain vacancies in this category.

On aggregate, the total forecasted demand for blockchain-related jobs across Europe is positive (26,837), between 2021 and 2026. Interestingly, this is largely driven by growth in *Sales, Marketing and Public Relations Professionals* and *Legal Professionals*. While CEDEFOP occupational forecasts predict faster overall growth in other occupational categories (e.g. *Software and Applications Developers and Analysts* and *Administration Professionals*), the proportion of vacancies that are blockchain related (calculated from the 2023 LinkedIn data) is larger for *Sales, Marketing and Public Relations Professionals* (6.1% on average) and *Legal Professionals* (3.5% on average), resulting in more vacancies being forecasted in this occupational category.



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Blockchain demand in occupations with minor blockchain representation is presented by the ‘*Other ISCO Categories*’. It accounts for approximately 7% of the total forecasted additional blockchain jobs and is included in the analysis for a complete representation of the blockchain labour market in Europe.



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Table 3: Forecasted Blockchain Demand by Blockchain-Relevant ISCO Occupations, 2021-2025

Country	Software and Applications Developers and Analysts		Database and Network Professionals		Information and Communications Technology Service Managers		Business Services and Administration Managers		Legal Professionals	
	(ISCO 251)		(ISCO 252)		(ISCO 133)		(ISCO 121)		(ISCO 261)	
	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand
Austria	4,094	48	1,023	28	-199	-9	1,676	20	1,773	34
Belgium	16,984	127	2,765	109	895	11	5,296	15	6,483	100
Bulgaria	3,303	53	901	59	-564	-20	857	52	763	103
Croatia	3,164	57	558	26	-12	0	804	0	1,884	118
Cyprus	785	12	128	0	212	7	189	12	500	0
Czechia	19,817	65	10,209	0	-408	-2	551	2	4,621	225
Denmark	12,206	114	1,509	28	291	4	1,455	9	2,110	114
Estonia	2,034	32	831	0	274	30	813	0	408	16
Finland	6,129	36	606	21	-10	0	-375	-4	962	0
France	52,456	142	13,114	362	9,699	124	-21,084	-209	6,662	14
Germany	29,925	102	4,871	150	-2,009	-22	9,546	74	8,123	67
Greece	3,623	40	690	6	-46	-1	-898	0	2,337	0
Hungary	4,012	25	1,639	9	79	1	-2,940	0	1,536	0
Ireland	6,306	79	1,720	15	730	26	7,780	147	1,176	26
Italy	11,472	220	3,824	447	-407	-6	-183	-1	20,205	1,127
Latvia	1,010	11	731	0	-10	0	321	0	460	0
Lithuania	2,527	30	934	16	-223	-14	190	8	223	0



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Table 3: Forecasted Blockchain Demand by Blockchain-Relevant ISCO Occupations, 2021-2025

	Software and Applications Developers and Analysts		Database and Network Professionals		Information and Communications Technology Service Managers		Business Services and Administration Managers		Legal Professionals	
	(ISCO 251)		(ISCO 252)		(ISCO 133)		(ISCO 121)		(ISCO 261)	
Country	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand
Luxembourg	1,962	56	725	13	62	4	215	5	2,365	113
Malta	502	24	137	0	51	5	-77	-3	215	7
Netherlands	21,551	101	6,078	129	-803	-17	-4,281	-45	5,224	27
Poland	30,614	251	5,831	141	-1,703	-46	11,462	264	6,012	415
Portugal	13,831	127	6,214	194	-325	-11	1,702	60	4,299	351
Romania	16,027	106	1,981	33	-36	-1	2,123	17	12,876	859
Slovakia	5,003	155	1,495	34	313	13	2,072	230	-140	-9
Slovenia	1,710	26	466	0	-56	0	303	13	555	56
Spain	19,410	157	8,319	463	-955	-18	4,565	40	6,361	36
Sweden	14,083	49	2,293	45	1,562	13	1,665	16	4,753	58
Total	298,231	2,166	77,873	2,314	5,673	45	15,966	576	101,570	3,830

Notes: Total demand for each 3-digit ISCO category is estimated by finding their proportions from EU-LFS for each country and applying them to absolute changes in 2-digit ISCO categories from CEDEFOP forecasts in Table 2. The Blockchain demand for each country is estimated by applying the percentage of 3-digit ISCO occupations (Table 5) that are Blockchain jobs to 'Total Demand' figures. Total forecasted Blockchain jobs from 2021 to 2026 for each country are listed in the final column of Table 4. (*) For Bulgaria, Malta and Slovenia, 3-digit ISCO employment data from EU-LFS was unavailable. Therefore, we estimate the average proportion of 3-digit ISCO across Europe in each of 2-digit ISCO categories (ISCO 251: 79%; ISCO 252: 21%; ISCO 133: 10%; ISCO 121: 60%; ISCO 261: 29%) and apply it to CEDEFOP occupational forecast data and estimate the forecasted additional blockchain jobs in these countries.



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Table 4: Forecasted Blockchain Demand by Blockchain-Relevant ISCO Occupations

Country	Sales, Marketing and Development Managers (ISCO 122)		Finance Professionals (ISCO 241)		Administration Professionals (ISCO 242)		Sales, Marketing and Public Relations Professionals (ISCO 243)		Other ISCO Categories	Total Forecasted Additional Blockchain Jobs 2021-2025	Total Forecasted Additional Blockchain Jobs (Augmented) 2021-2026
	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Blockchain Demand	Blockchain Demand	Blockchain Demand
Austria	2,515	13	-260	-3	-246	0	-178	-4	21	148	185
Belgium	6,472	17	7,018	27	7,776	4	4,173	57	9	474	593
Bulgaria	570	24	-223	-6	-231	-5	-150	-16	8	253	317
Croatia	313	2	1,185	185	1,388	96	812	116	46	646	808
Cyprus	181	2	300	14	200	3	125	0	4	53	67
Czechia	194	1	9,433	148	8,465	22	6,289	510	75	1,047	1,308
Denmark	653	2	4,073	79	7,332	0	2,172	24	29	402	503
Estonia	666	16	174	14	108	6	66	6	22	143	179
Finland	-459	-1	3,236	72	5,565	0	4,141	388	39	551	689
France	-18,698	-77	22,135	66	27,909	11	46,194	504	19	956	1,195
Germany	6,633	15	12,397	69	19,549	16	15,734	57	25	553	691
Greece	-1,143	-12	422	0	72	1	109	2	2	37	46
Hungary	-560	-1	1,161	8	1,502	56	751	51	8	157	196
Ireland	1,266	3	4,153	37	6,418	58	8,306	718	25	1,135	1,418
Italy	-311	-1	23,704	341	21,782	85	18,579	191	104	2,509	3,136
Latvia	52	0	176	8	684	0	176	29	4	53	66
Lithuania	126	1	573	20	837	71	793	88	5	225	281



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Table 4: Forecasted Blockchain Demand by Blockchain-Relevant ISCO Occupations

Country	Sales, Marketing and Development Managers (ISCO 122)		Finance Professionals (ISCO 241)		Administration Professionals (ISCO 242)		Sales, Marketing and Public Relations Professionals (ISCO 243)		Other ISCO Categories	Total Forecasted Additional Blockchain Jobs 2021-2025	Total Forecasted Additional Blockchain Jobs (Augmented) 2021-2026
	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Total Demand	Blockchain Demand	Blockchain Demand	Blockchain Demand	Blockchain Demand
Luxembourg	38	1	5,473	50	5,124	143	1,048	150	31	565	706
Malta	-51	-1	230	10	238	0	155	0	3	44	56
Netherlands	-3,502	-5	12,764	50	24,997	32	15,424	77	27	377	471
Poland	5,394	19	26,252	265	37,627	395	23,626	2,030	315	4,048	5,060
Portugal	1,509	5	8,528	216	3,676	57	2,500	121	20	1,141	1,426
Romania	2,701	8	47,145	424	19,583	519	5,802	271	172	2,409	3,011
Slovakia	1,696	8	1,607	81	343	7	685	31	25	576	720
Slovenia	202	3	1,246	69	1,286	0	836	120	22	309	386
Spain	4,565	4	11,244	118	19,407	309	10,911	344	305	1,756	2,196
Sweden	647	1	7,735	47	24,920	0	9,073	494	178	903	1,129
Total	10,403	45	207,727	2,374	239,894	1,826	169,848	5,641	1,518	21,470	26,837

Notes: Total demand for each 3-digit ISCO category is estimated by finding their proportions from EU-LFS for each country and applying them to absolute changes in 2-digit ISCO categories from CEDEFOP forecasts in Table 2. The Blockchain demand for each country is estimated by applying the percentage of 3-digit ISCO occupations (Table 5) that are Blockchain jobs to 'Total Demand' figures. Total forecasted Blockchain jobs from 2021 to 2026 for each country are listed in the final column of Table 4. (*) For Bulgaria, Malta and Slovenia, 3-digit ISCO employment data from EU-LFS was unavailable. Therefore, we estimate the average proportion of 3-digit ISCO across Europe in each of 2-digit ISCO categories (ISCO 251: 79%; ISCO 252: 21%; ISCO 133: 10%; ISCO 121: 60%; ISCO 261: 29%) and apply it to CEDEFOP occupational forecast data and estimate the forecasted additional blockchain jobs in these countries.



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Table 5: Proportion of Jobs in each ISCO Category that are Blockchain Jobs - EU-27

	Business Services and Administration Managers	Sales, Marketing and Development Managers	ICT Service Managers	Finance Professionals	Administration Professionals	Sales, Marketing and Public Relations Professionals	Software and Applications Developers and Analysts	Database and Network Professionals	Legal Professionals
Country	ISCO 121	ISCO 122	ISCO 133	ISCO 241	ISCO 242	ISCO 243	ISCO 251	ISCO 252	ISCO 261
Austria	1.19%	0.52%	4.37%	1.07%	0.10%	2.01%	1.17%	2.78%	1.89%
Belgium	0.28%	0.26%	1.22%	0.38%	0.05%	1.36%	0.75%	3.93%	1.54%
Bulgaria	6.08%	4.26%	3.57%	2.60%	1.98%	10.34%	1.59%	6.58%	13.51%
Croatia	0.00%	0.76%	0.00%	15.63%	6.90%	14.29%	1.80%	4.62%	6.25%
Cyprus	6.38%	1.20%	3.23%	4.65%	1.27%	0.00%	1.53%	0.00%	0.00%
Czechia	0.39%	0.41%	0.53%	1.57%	0.26%	8.11%	0.33%	0.00%	4.88%
Denmark	0.62%	0.33%	1.26%	1.95%	0.00%	1.10%	0.93%	1.83%	5.41%
Estonia	0.00%	2.46%	11.11%	8.06%	5.66%	9.33%	1.59%	0.00%	4.00%
Finland	0.96%	0.30%	0.00%	2.22%	0.00%	9.38%	0.59%	3.39%	0.00%
France	0.99%	0.41%	1.28%	0.30%	0.04%	1.09%	0.27%	2.76%	0.21%
Germany	0.77%	0.23%	1.10%	0.56%	0.08%	0.36%	0.34%	3.08%	0.83%
Greece	0.00%	1.04%	2.92%	0.00%	0.71%	1.67%	1.11%	0.83%	0.00%
Hungary	0.00%	0.18%	1.09%	0.65%	3.70%	6.78%	0.63%	0.56%	0.00%
Ireland	1.89%	0.27%	3.55%	0.89%	0.90%	8.64%	1.25%	0.90%	2.24%
Italy	0.40%	0.17%	1.47%	1.44%	0.39%	1.03%	1.92%	11.68%	5.58%
Latvia	0.00%	0.92%	0.00%	4.44%	0.00%	16.67%	1.11%	0.00%	0.00%



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Table 5: Proportion of Jobs in each ISCO Category that are Blockchain Jobs - EU-27

	Business Services and Administration Managers	Sales, Marketing and Development Managers	ICT Service Managers	Finance Professionals	Administration Professionals	Sales, Marketing and Public Relations Professionals	Software and Applications Developers and Analysts	Database and Network Professionals	Legal Professionals
Country	ISCO 121	ISCO 122	ISCO 133	ISCO 241	ISCO 242	ISCO 243	ISCO 251	ISCO 252	ISCO 261
Lithuania	4.08%	0.90%	6.12%	3.42%	8.43%	11.11%	1.17%	1.75%	0.00%
Luxembourg	2.55%	1.53%	6.06%	0.92%	2.79%	14.29%	2.84%	1.82%	4.76%
Malta	3.57%	2.31%	10.34%	4.26%	0.00%	0.00%	4.70%	0.00%	3.03%
Netherlands	1.05%	0.15%	2.06%	0.39%	0.13%	0.50%	0.47%	2.13%	0.51%
Poland	2.30%	0.36%	2.72%	1.01%	1.05%	8.59%	0.82%	2.42%	6.90%
Portugal	3.55%	0.30%	3.33%	2.53%	1.55%	4.83%	0.92%	3.13%	8.16%
Romania	0.79%	0.31%	1.92%	0.90%	2.65%	4.67%	0.66%	1.67%	6.67%
Slovakia	11.11%	0.48%	4.11%	5.06%	2.08%	4.49%	3.09%	2.27%	6.25%
Slovenia	4.35%	1.41%	0.00%	5.56%	0.00%	14.29%	1.53%	0.00%	10.00%
Spain	0.87%	0.08%	1.91%	1.05%	1.59%	3.15%	0.81%	5.57%	0.56%
Sweden	0.96%	0.11%	0.85%	0.61%	0.00%	5.45%	0.35%	1.98%	1.23%
Average	2.05%	0.82%	2.79%	2.74%	1.59%	5.96%	1.27%	2.49%	3.55%

Notes: The proportion of jobs in each ISCO category that are blockchain jobs was estimated by dividing the number blockchain jobs in a specific ISCO category by the total number of jobs in that ISCO category. This was estimated for each ISCO category and for each European state. The following keywords were used to derive the total number of jobs in each ISCO category from LinkedIn: ISCO 251: “software developer” and “analyst software”; ISCO 252: “database and network”; ISCO 133: “IT manager”; ISCO 121: “business services manager”; ISCO 261: “lawyer”.



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As outlined in the *Methodology* section, this year's forecast expanded its occupational mapping procedure to include four additional ISCO 3-Digit occupations at the request of CHAISE partners and international blockchain stakeholders. The advantage of this is that the expanded forecasts provide a more granular occupational analysis of blockchain skills demand, accounting for a greater variety of occupations. However, the trade-off is that it is no longer possible to directly compare the occupational composition of our scraped sample in 2023 to samples of previous forecasts due to the expanded occupational categorisation. For example, a vacancy that may have been mapped to Administration Professionals (ISCO 242) this year could have been mapped to Business Services and Administration Managers (ISCO 121) in 2021 or 2022 (i.e. without the additional categories). This means that we cannot accurately compare samples across time.⁶

⁶ For a comparison between samples in previous reports, please see Table 6 in McGuinness et al. (2023), pp. 32-33.



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3.3 Blockchain Skills Supply

The total number of ICT graduates per year from 2015 to 2021 for each European country is presented in Table 6. Since most blockchain employment comes from the ICT field of study we utilise the number of graduates from this field to estimate the proportion of ICT graduates with exposure to blockchain learning, and therefore, blockchain skills supply. Evidently, the number of ICT graduates across Europe has been increasing on average at 5.95% per year from 2015 to 2021 which is indicative of the continuous expansion of the ICT sector at a European level. This suggests that the blockchain sector across Europe could have been growing at that time. However, the extent of growth in the blockchain sector and applicable skills supply is unknown due to the lack of appropriate data on blockchain-specific graduates.

In order to estimate blockchain graduate supply in the EU-27, the CHAISE consortium was consulted to provide national statistics on the number of graduates with blockchain exposure from blockchain-specific courses or graduates with at least some exposure to blockchain content (herein referred to as “blockchain graduates”). To forecast blockchain skills supply, the proportion of ICT graduates that are coming from blockchain-related courses is estimated. We find that on average 2.19% of ICT graduates in Europe graduated having had some exposure to blockchain learning. The number of ICT graduates over the examination period and the proportion of graduates with exposure to blockchain learning in 2021 are used to estimate the change in blockchain labour market and skills supply from 2021 to 2026.



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Table 6: Total ICT Graduates by EU-27 Country, 2015-2021 (Eurostat)

Country	2015	2016	2017	2018	2019	2020	2021
Austria	2,555	2,574	2,435	2,549	2,704	2,717	3,070
Belgium	1,229	1,847	2,146	2,454	2,445	2,728	2,943
Bulgaria	1,957	1,733	2,127	2,055	2,084	2,147	2,335
Croatia	-	1,666	1,876	1,383	1,461	1,603	1,679
Cyprus	225	204	229	229	289	258	322
Czechia	3,848	3,648	3,964	3,758	3,662	3,630	3,720
Denmark	2,696	3,224	3,252	3,244	3,405	3,650	4,061
Estonia	516	652	713	604	718	766	975
Finland	3,784	3,958	3,538	4,065	4,342	4,762	4,541
France	18,359	18,801	19,442	20,459	20,994	29,810	25,780
Germany	24,755	25,332	26,731	27,456	29,513	29,305	32,703
Greece	1,984	2,211	1,998	2,174	2,393	2,427	2,895
Hungary	1,455	2,813	2,523	2,754	2,852	5,338	3,712
Ireland	4,449	4,851	5,275	6,251	6,271	7,154	7,008
Italy	-	3,211	3,328	4,549	5,103	5,657	6,897
Latvia	550	527	523	512	463	550	587
Lithuania	587	601	760	818	921	974	1132
Luxembourg	84	88	75	94	78	109	86
Malta	242	240	271	270	270	276	339
Netherlands	3,101	3,463	3,730	4,311	4,789	5,329	6,387
Poland	15,744	15,214	18,259	17,911	17,270	15,379	16,564
Portugal	862	806	942	1,070	1,163	1,399	1,488
Romania	8,460	8,572	9,379	9,905	10,758	11,688	9,054
Slovakia	1,734	1,753	1,653	1,718	1,562	1,670	1,721
Slovenia	-	-	952	978	1,029	962	1093
Spain	7,662	7,456	7,876	7,173	7,365	8,402	9,321
Sweden	2,075	2,088	2,139	2,199	2,340	2,729	3,231
Total	108,913	117,533	126,136	130,943	136,244	151,419	153,644

Note: Data for total ICT graduates comes from CHAISE partner submissions and Eurostat (Code: educ_uae_grad02).



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3.4 Blockchain Skills Supply Forecast

Forecasts of ICT graduates and blockchain graduates for each European country from 2021 to 2026 are presented in Table 7. ICT graduate forecasts are based on the number of graduates from 2015 to 2021 in Table 6. We forecast that the number of ICT graduates across Europe will grow on an average at 3.8% per year from 2021 to 2026. Therefore, the total forecasted ICT graduate supply in Europe over the sample period is 1,029,417. Using data supplied by CHAISE partners on the number of graduates with blockchain exposure in 2021, the average proportion of ICT graduates that are blockchain graduates is calculated as 2.49%. This was calculated using data provided by Austria (0.48%), Belgium (5.45%), Estonia (2.26%), France (3.77%), Germany (0.99%), Ireland (2.50%), Italy (3.56%), Slovenia (3.60%) and Spain (0.76%). For countries where blockchain graduate data was available, the country-specific proportions were used to calculate forecasted blockchain graduates. For countries where data was not available, the average of 2.49% was used. Last year's forecasting results indicated that on average approximately 2.56% of ICT graduates in Europe would be from blockchain specific courses. Current forecasting results incorporate more complete and up-to-date information on graduates with blockchain exposure, and therefore provide a more accurate forecasting of blockchain skills supply.

Forecasted total blockchain graduate supply in Europe over the period from 2021 to 2026 is 24,415. This is slightly lower than last year's estimation of graduate supply (25,557). This is driven by considerable downward revisions in graduate supply for Romania, France, Poland and Hungary relative to the 2022 CHAISE Blockchain Skills Forecast (McGuinness *et al.* 2023). Countries with a larger population or greater number of ICT graduates are likely to contribute more to the supply of blockchain skills in Europe. The countries that are forecasted on average to experience a significant growth in the number of ICT graduates, and therefore blockchain graduates, over the sample period are Italy (8.9% p.a.), Hungary (8.0% p.a.), the Netherlands (7.2% p.a.), Belgium (7.1% p.a.) and Lithuania (6.88% p.a.). A minority of countries, namely Croatia, Czechia, Slovakia, and Slovenia, are forecasted to experience a relatively insignificant negative trend in the number of ICT graduates.



Table 7: Forecasted ICT and Blockchain Graduates by Country

Country	2021*	2022	2023	2024	2025	2026	Total Forecasted ICT Graduates: 2021 - 2025	Total Forecasted ICT Graduates: 2021 - 2026	Forecasted Blockchain Graduate Supply: 2021-2025	Forecasted Blockchain Graduate Supply: 2021-2026
Austria	3,070	2,958	3,033	3,108	3,183	3,258	15,351	18,609	65	79
Belgium	2,943	3,285	3,542	3,800	4,057	4,314	17,627	21,941	1,012	1,260
Bulgaria	2,335	2,337	2,405	2,474	2,542	2,611	12,093	14,704	273	367
Croatia	1,679	1,544	1,524	1,505	1,486	1,466	7,738	9,205	175	230
Cyprus	322	316	333	349	366	382	1,686	2,068	38	52
Czechia	3,720	3,644	3,618	3,592	3,567	3,541	18,141	21,682	409	541
Denmark	4,061	4,090	4,272	4,455	4,637	4,819	21,515	26,334	485	657
Estonia	975	936	994	1,051	1,109	1,166	5,065	6,231	94	115
Finland	4,541	4,810	4,978	5,145	5,312	5,479	24,786	30,266	559	755
France	25,780	26,674	27,867	29,061	30,254	31,447	139,636	171,084	5,671	6,948
Germany	32,703	32,910	34,144	35,379	36,614	37,848	171,750	209,598	1,654	2,012
Greece	2,895	3,193	3,228	3,264	3,299	3,334	15,879	19,213	358	479
Hungary	3,712	4,800	5,234	5,667	6,101	6,535	25,514	32,049	576	799
Ireland	7,008	7,791	8,265	8,740	9,214	9,688	41,018	50,706	1,024	1,266
Italy	6,897	7,879	8,684	9,488	10,292	11,097	43,240	54,337	1,285	1,615
Latvia	587	544	548	551	555	558	2,784	3,342	63	83
Lithuania	1,132	1,191	1,282	1,372	1,463	1,554	6,440	7,993	145	199
Luxembourg	86	95	97	99	100	102	477	579	11	14



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Table 7: Forecasted ICT and Blockchain Graduates by Country

Country	2021*	2022	2023	2024	2025	2026	Total Forecasted ICT Graduates: 2021 - 2025	Total Forecasted ICT Graduates: 2021 - 2026	Forecasted Blockchain Graduate Supply: 2021-2025	Forecasted Blockchain Graduate Supply: 2021-2026
Malta	339	324	337	350	363	376	1,714	2,090	39	52
Netherlands	6,387	6,537	7,060	7,583	8,107	8,630	35,674	44,304	805	1,105
Poland	16,564	16,877	16,942	17,006	17,070	17,135	84,460	101,594	1,905	2,533
Portugal	1,488	1,574	1,691	1,808	1,926	2,043	8,486	10,529	191	263
Romania	9,054	10,503	10,985	11,466	11,947	12,429	53,956	66,384	1,217	1,655
Slovakia	1,721	1,645	1,634	1,624	1,613	1,603	8,238	9,840	186	245
Slovenia	1093	1,164	1,123	1,083	1,109	1,136	5,572	6,708	184	221
Spain	9,321	8,802	9,029	9,256	9,483	9,710	45,891	55,601	295	358
Sweden	3,231	3,107	3,284	3,461	3,638	3,815	16,722	20,536	377	512
Total	153,644	159,530	166,133	172,737	179,407	186,076	831,451	1,017,527	19,097	24,415

Notes: (*) 2021 figures are taken directly from Eurostat and not forecasted. Total forecasted ICT graduates are estimated by applying a linear trend to total ICT graduates from 2015 to 2021 in Table 6. Estimated Blockchain skills supply for each country is the share of blockchain-specific graduates of total ICT graduates. The share of blockchain-specific graduates on average is 2.49% of total ICT graduates, which is applied to countries that did not provide specific blockchain graduate data. The average proportion of blockchain-specific graduates is estimated as a simple average based on the information provided by the following CHAISE partners: Austria (0.42%), Belgium (5.74%), Estonia (1.85%), France (4.06%), Germany (0.96%), Ireland (2.50%), Italy (2.97%), Slovenia (3.29%) and Spain (0.64%).

3.5 Comparing Demand and Supply Forecasts

In order to compare forecasted blockchain graduate demand and supply, the proportion of blockchain related jobs that are advertised at 'entry-level' is estimated and presented for each country in Table 8.⁷ We find that on average across all European states approximately 43% of advertised blockchain related jobs are at entry level and for new higher education graduates. The total forecasted blockchain new entrant demand in Europe from 2021 to 2026 is 11,663. In terms of graduate supply (Table 7), 1,017,527 higher education students are expected to graduate from the ICT field of study across the EU-27, and we estimate that 24,415 of new ICT graduates will have some blockchain learning exposure between 2021 and 2026. The results in Table 8 indicate that total forecasted blockchain graduate supply will greatly outweigh the demand for new entrants to the blockchain sector in Europe. It should also be noted that many of the ICT graduates without exposure to blockchain modules will have some knowledge and skills to perhaps enter blockchain vacancies where on-the-job training would be provided. The resulting forecasts will enable individual member states to assess the extent to which labour market imbalances are likely to occur in the short-term and provide important input into the development of a more strategic approach to the delivery of a blockchain skills strategy.

The results in Table 8 show that on aggregate, graduate supply is likely to satisfy graduate demand in Europe during the sample period, albeit with variation between countries. For most countries in Europe, forecasted graduate demand and supply are not symmetrical, meaning some level of blockchain skills surplus or shortage is expected. For example, forecasted graduate demand and supply are broadly in line for Poland, Czechia, Sweden and Italy. Shortages of blockchain skills at the national, graduate level are forecast in Romania, Croatia, Luxembourg, Portugal and Spain. Conversely, sizeable surpluses of blockchain skills are forecasted in Denmark, Finland, the Netherlands, Ireland, Hungary, Bulgaria, France, Belgium, Greece and Germany. Figures 3 to 6 (overleaf) present a direct comparison between blockchain graduate demand and blockchain graduate supply by regional groups across Europe.

⁷ We cannot directly compare forecasted total blockchain demand with forecasted blockchain graduate supply as total blockchain demand captures vacancies for positions that are more senior (i.e. require more experience) than entry-level positions, and we do not observe more experienced blockchain workers in our supply forecast.



Table 8: Forecast Summary for Demand and Supply, 2021-2026

Country	Total Blockchain Demand (Augmented, #)	Blockchain Graduate Demand (%)	Blockchain Graduate Demand (Augmented, #)	Total ICT Graduate Supply	Blockchain Graduate Supply
Austria	185	46.32%	86	18,609	79
Belgium	593	41.81%	248	21,941	1,260
Bulgaria	317	37.11%	118	14,704	367
Croatia	808	56.25%	454	9,205	230
Cyprus	67	27.63%	18	2,068	52
Czechia	1,308	43.33%	567	21,682	541
Denmark	503	27.50%	138	26,334	657
Estonia	179	49.44%	89	6,231	115
Finland	689	51.32%	354	30,266	755
France	1,195	28.33%	339	171,084	6,948
Germany	691	32.10%	222	209,598	2,012
Greece	46	44.12%	20	19,213	479
Hungary	196	45.83%	90	32,049	799
Ireland	1,418	33.16%	470	50,706	1,266
Italy	3,136	50.47%	1,583	54,337	1,615
Latvia	66	39.58%	26	3,342	83
Lithuania	281	29.17%	82	7,993	199
Luxembourg	706	40.00%	282	579	14
Malta	56	25.00%	14	2,090	52
Netherlands	471	31.77%	150	44,304	1,105
Poland	5,060	37.86%	1,916	101,594	2,533
Portugal	1,426	33.73%	481	10,529	263
Romania	3,011	64.63%	1,946	66,384	1,655
Slovakia	720	55.43%	399	9,840	245
Slovenia	386	36.36%	140	6,708	221
Spain	2,196	39.53%	868	55,601	358
Sweden	1,129	50.00%	564	20,536	512
Total	26,837	43.46%	11,663	1,017,527	24,415

Notes: Total Blockchain Demand (#) comes from Table 4 on *Forecasting Blockchain Demand by Blockchain-Relevant ISCO occupations, 2021-2026*. Blockchain Graduate Demand (%) is the percentage of Total Blockchain Demand that is for Entry-level positions. (*) Blockchain Graduate Demand was not available for Czechia and the Netherlands. Therefore, we use average Blockchain Graduate Demand percentage for Czechia and the Netherlands. Total ICT Graduate Supply and Blockchain Graduate Supply comes from Table 7 on *Forecasted ICT and Blockchain Graduates by Country, 2021-2026*.



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Figure 2 compares total forecasted blockchain skills demand and supply from 2021 to 2026 using data from the current year of forecasting (2023) and the previous two years of forecasting (2022 and 2021) across all EU-27 countries. Table 9 shows country-specific breakdown of total forecasted blockchain demand and supply using information across all years of forecasting. The results indicate that there has been a decrease in forecasted blockchain skills demand during the sample period from 29,383 vacancies, according to the 2022 forecasts, to 26,837 vacancies, according to the 2023 forecasts. The proportion of blockchain jobs advertised at the entry-level or for new graduates has remained approximately the same (43%). As a result, the 2023 forecasts indicate a decrease in total forecasted blockchain graduate demand from 13,278, using 2022 data, to 11,663, using 2023 data. In terms of blockchain graduate supply, the most recent forecasts indicate a decrease in forecasted blockchain graduate supply (between 2021 and 2026) from 25,557, using 2022 data, to 24,415 using 2023 data.

Total forecasted demand has been revised downward relative to the previous two years' reports. Nevertheless, blockchain graduate supply has consistently been forecasted to be greater than blockchain graduate demand across the EU-27 in all three forecasting reports. This indicates that, at the graduate level, demand is likely to be satisfied by supply. However, it is unclear whether total demand will be satisfied by supply, given that the forecasting model does not observe or forecast non-graduate blockchain skills supply.



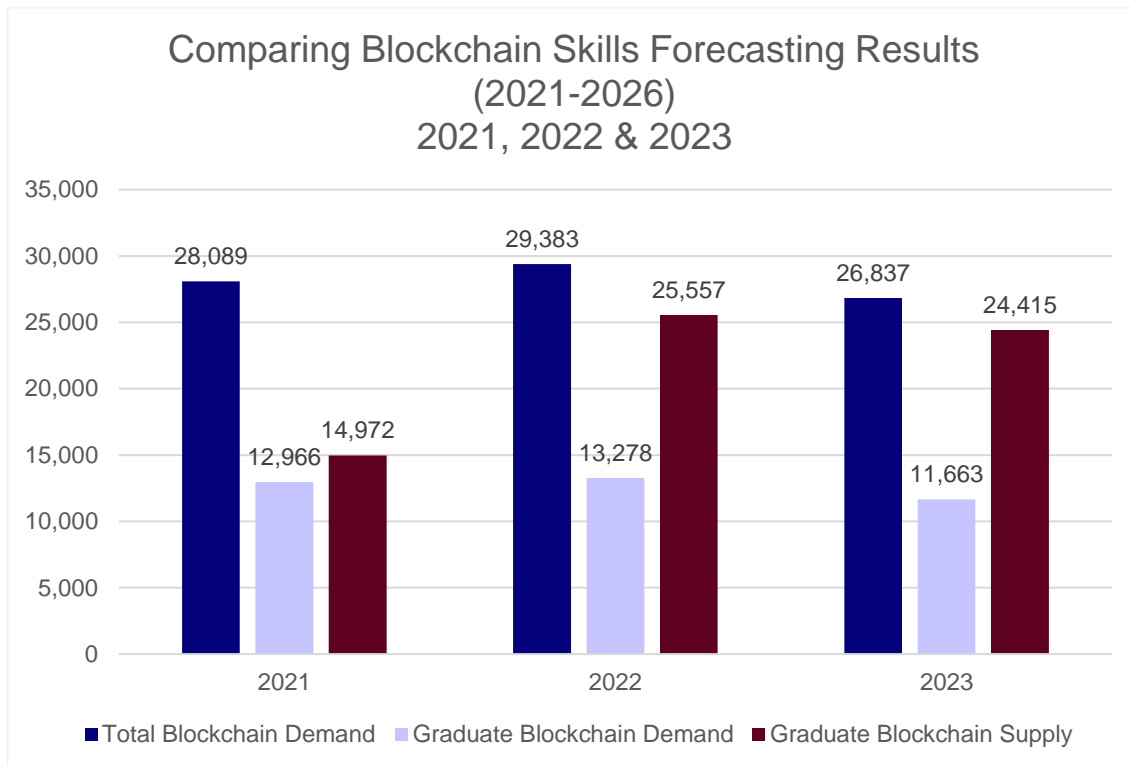


Figure 2 - Comparing Blockchain Skills Forecasting Results From 2021 to 2026



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Table 9: Comparing Forecasted Blockchain Skills Demand and Supply: 2021 - 2026

Country	Total Blockchain Demand			Total Graduate Demand			Total Blockchain Graduate Supply		
	Annual Forecasts From 2021 (2021-2026)	Updated Annual Forecasts in 2022 (2021-2026)	Updated Annual Forecasts in 2023 (2021-2026: Augmented)	Annual Forecasts From 2021 (2021-2026)	Updated Annual Forecasts in 2022 (2021-2026)	Updated Annual Forecasts in 2023 (2021-2026: Augmented)	Annual Forecasts From 2021 (2021-2026)	Updated Annual Forecasts in 2022 (2021-2026)	Updated Annual Forecasts in 2023 (2021-2026)
Austria	197	245	185	93	101	86	305	81	79
Belgium	1,486	440	593	566	124	248	549	1,238	1,260
Bulgaria	160	41	317	-	15	118	245	362	367
Croatia	68	32	808	35	21	454	104	200	230
Cyprus	153	755	67	100	309	18	34	48	52
Czechia	797	553	1,308	478	0	567	380	603	541
Denmark	720	1,477	503	377	495	138	423	708	657
Estonia	414	489	179	190	234	89	90	121	115
Finland	111	-22	689	44	-13	354	490	802	755
France	9,899	10,470	1,195	3,578	3,015	339	1,173	7,335	6,948
Germany	1,720	3,879	691	827	1,633	222	3,543	1,981	2,012
Greece	27	47	46	15	25	20	529	417	479
Hungary	486	293	196	290	153	90	433	978	799
Ireland	846	955	1,418	371	222	470	390	1,237	1,266



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Italy	1,825	2,101	3,136	1,030	947	1,583	823	1,717	1,615
Latvia	151	372	66	76	212	26	42	75	83
Lithuania	216	81	281	137	44	82	133	198	199
Luxembourg	87	166	706	26	65	282	8	17	14
Malta	-	-	56	-	-	14	33	47	52
Netherlands	-648	-70	471	-254	-31	150	673	1,050	1,105
Poland	4,091	1,584	5,060	-	528	1,916	2,135	2,670	2,533
Portugal	986	640	1,426	766	250	481	156	263	263
Romania	54	43	3,011	33	29	1,946	916	2,124	1,655
Slovakia	171	700	720	122	448	399	153	237	245
Slovenia	158	1,189	386	-	573	140	210	220	221
Spain	2,113	2,115	2,196	849	664	868	733	370	358
Sweden	1,801	807	1,129	1,056	383	564	268	457	512
Total	28,089	29,383	26,837	12,966	13,278	11,663	14,972	25,557	24,415



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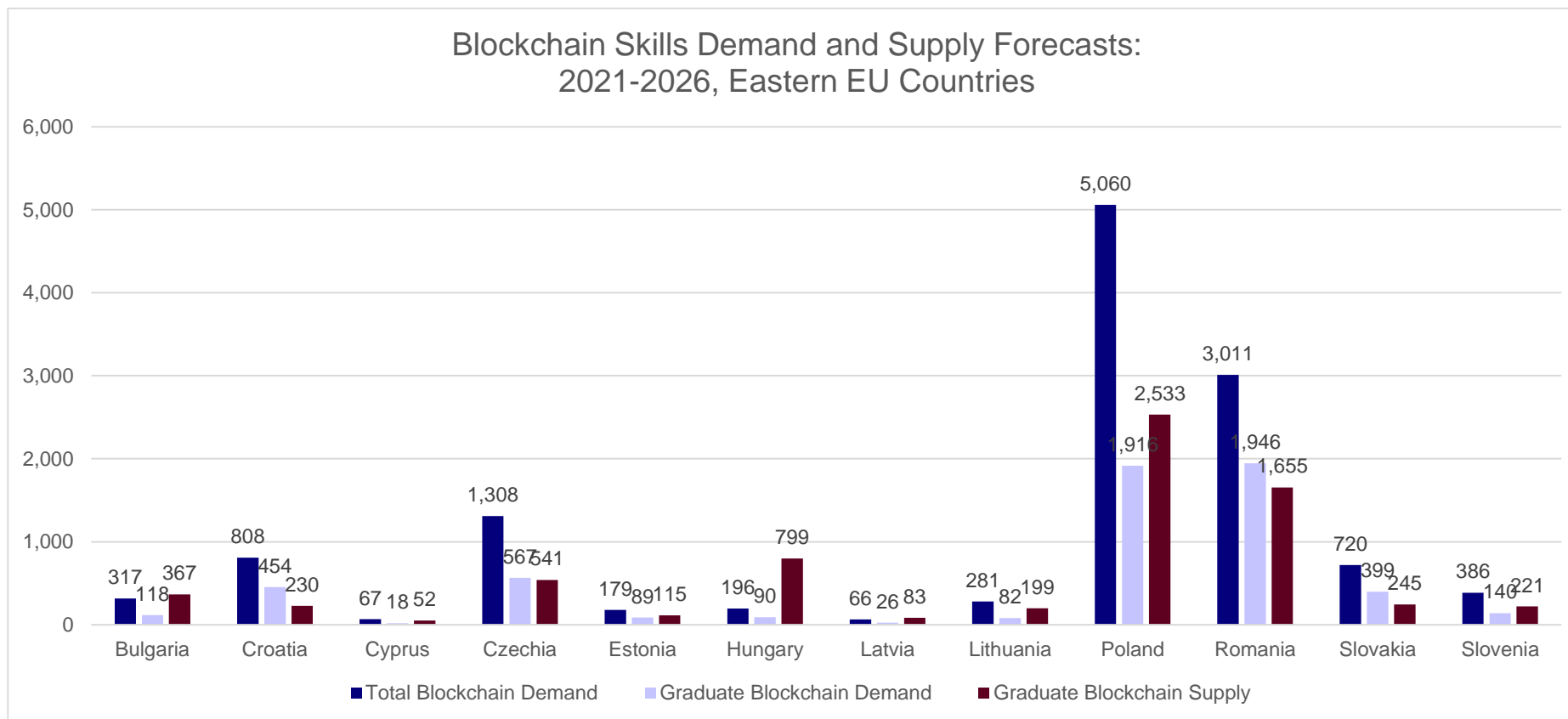


Figure 3 - Blockchain Skills Demand and Supply Forecasts 2021-2026, Eastern EU Countries



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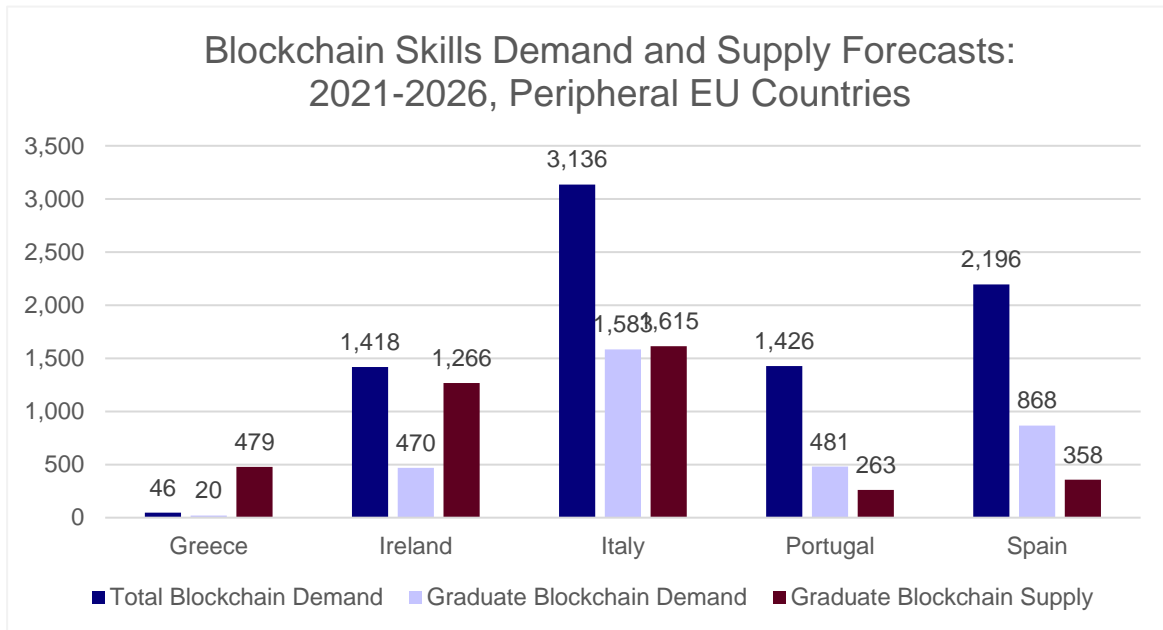


Figure 4 - Blockchain Skills Demand and Supply Forecasts 2021-2026: Peripheral EU Countries

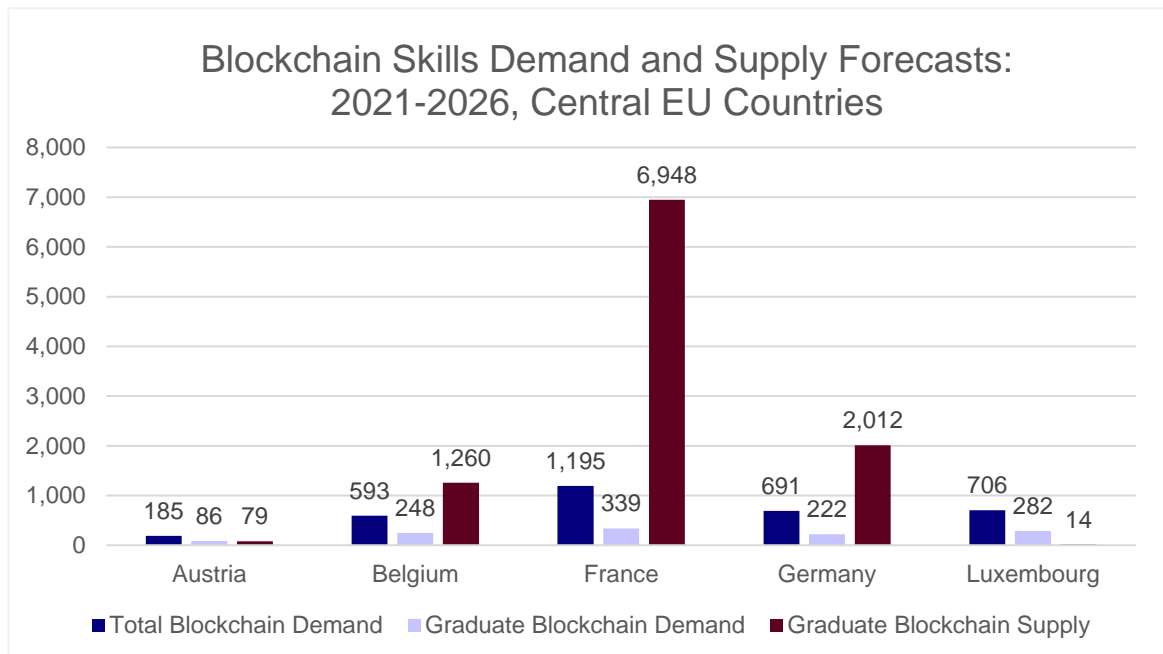


Figure 5 - Blockchain Skills Demand and Supply Forecasts 2021-2026: Central EU Countries



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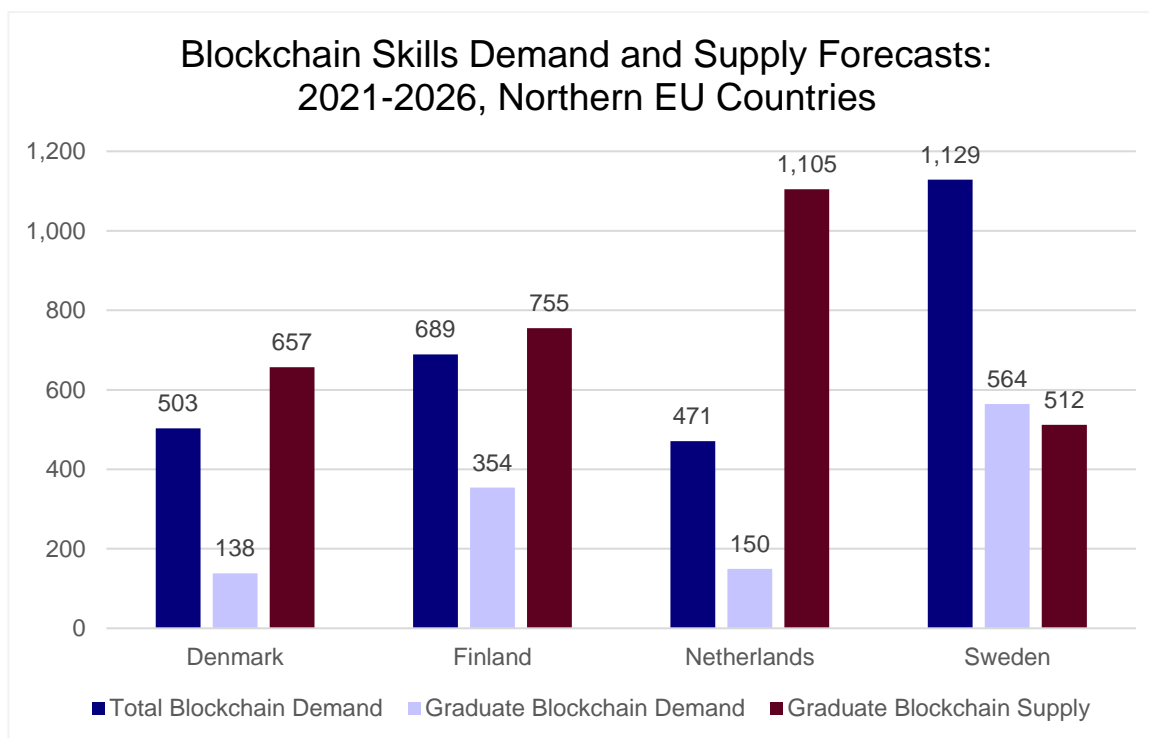


Figure 6 - Blockchain Skills Demand and Supply Forecasts 2021-2026, Northern EU Countries

3.6 Conclusions

Across the EU-27, forecasted blockchain graduate supply is predicted to be sufficiently large to satisfy blockchain graduate demand between 2021 and 2026. This finding has remained consistent across three years of forecasting. However, it is important to recognise that significant variation in supply and demand symmetry between countries is forecasted. In some countries, skills shortages at the graduate level are estimated. This considered, it is unclear whether these shortages will persist, given that blockchain graduates who complete their studies in a given country might move to work in another country. Furthermore, forecasted blockchain demand has been revised downward relative to previous years' figures. This is indicative of year-on-year reductions in demand for blockchain skills, as evidenced by the declining share of blockchain vacancies in LinkedIn job postings between 2021 and 2023 (see Table 1). While the data collection period substantiating this finding is relatively short, the extent to which



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the number of blockchain-related vacancies has fallen – reducing by 43% since 2021 – signals underlying volatility in the magnitude of blockchain skills demand.

In addition, blockchain skills demand is occupationally diverse. While the majority of all three scraped LinkedIn samples are comprised of ISCO 251: *Software and Applications Developers and Analysts*, the remaining occupations are substantially varied. While other technical professions such as ISCO 252: *Database and Network Professionals* are important, occupations typically requiring business or interpersonal skills (e.g. ISCO 243: *Sales, Marketing and Public Relations Professionals*) are also significant contributors to the occupational profile of blockchain vacancies. This is captured in the occupational composition of the blockchain skills demand forecasts.

The occupational profile of the blockchain demand forecasts varies significantly between countries. For example, over half (50.1%) of all forecasted blockchain vacancies in Poland is composed of ISCO 243: *Sales, Marketing and Public Relations Professionals*, while in Spain the same occupational category accounts for approximately 19.3%. However, without access to more granular data on blockchain skills supply (i.e. in relation to specific skills possessed by blockchain graduates), it is not possible to forecast whether specific occupational shortages in blockchain skills will be met.



4 Intelligence Gathering Activities

To supplement the forecasting results, CHAISE partners undertook intelligence gathering activities to complement the findings of the forecasting model. Four activities were undertaken:

1. *Sectoral Development Trends*: Partners from industry - Netcompany-INTRASOFT, IOTA, FUJITSU, and Crypto4All – provided reports on several factors influencing the blockchain skills environment in Europe.
2. *Education and Training Interviews*: Partners from educational bodies and training organisations – ECQA, CIMEA, ACQUIN and YPEPTH – conducted roundtable interviews with E&T providers and policy stakeholders on the broad topic of educational developments relating to blockchain skills.
3. *Document Analysis*: DIGITALEUROPE conducted desk-based research, consulting Cedefop documentation to produce a report relating to skills policies and regulation, economic developments and educational trends.
4. *Labour Market Analysis*: Using data provided by CHAISE partners, EXELIA conducted a detailed analysis of 1) blockchain job vacancies, 2) education and training courses and 3) blockchain use cases in Europe.

These four activities are calibrated to complement the forecasted supply and demand analysis reported in the previous section. Section 4.1 provides insights into the industrial perspective, which heavily relates to blockchain skills demand. Section 4.2 focuses on education and training, which are the primary drivers of blockchain skills supply. Section 4.3 and Section 4.4 attempt to characterise the blockchain landscape in Europe, providing broader context to the quantitative forecasting findings.

4.1 Sectoral Development Trends

The key findings on sectoral developments come from blockchain experts from Netcompany-INTRASOFT, IOTA, FUJITSU, and Crypto4All within the CHAISE consortium. Their analysis of sectoral developments and connections to future blockchain skill needs are based on an examination of policy developments, E&T initiatives, blockchain ecosystem, and challenges and opportunities in the blockchain sector. The findings provide additional insights into the future of the blockchain sector and blockchain skill needs and are summarised in the following sections.



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4.1.1 Blockchain Regulatory and Policy Developments

In 2023, the regulation on Markets in Crypto Assets (MiCA) proposal advanced through critical stages of discussion and negotiation among the European Parliament, Council, and Commission. This is a significant step towards establishing a comprehensive regulatory framework for crypto assets not covered by existing financial services legislation.

The Pilot Regime for Market Infrastructures based on Distributed Ledger Technology (DLT) – designed in 2022 and launched in March 2023, allows operators of market infrastructures to test DLT in the issuance, trading, and settlement of tokenized financial instruments. The pilot regime is designed to allow temporary derogations from existing rules to enable regulatory experimentation and innovation.

The Digital Operational Resilience Act (DORA) - a measure to enhance the overall digital operational resilience of the EU financial sector, was published on 27 December 2022, in the Official Journal of the European Union, and entered into force on 16 January 2023. DORA will apply from 17 January 2025. DORA aims to strengthen the operational resilience of the financial sector against cyber threats (including crypto assets and DLT platforms) and standardize the digital operational resilience requirements across the EU.

The EU Blockchain Regulatory Sandbox was also launched in 2023. The European Blockchain Regulatory Sandbox for innovative use cases involving Distributed Ledger Technologies (DLT) is an initiative of the European Commission. The sandbox establishes a pan-European framework for regulatory dialogues to increase legal certainty for innovative blockchain technology solutions. The sandbox will annually accept cohorts of 20 blockchain use cases. They will be matched with relevant national and EU regulators for a safe and constructive dialogue on the most relevant regulatory issues.

In addition, the eIDAS (Electronic Identification, Authentication, and Trust Services) regulation plays a crucial role in the Blockchain regulatory landscape in Europe. As of 2023, the eIDAS framework, which establishes trust in electronic transactions through identification and authentication services, digital



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signatures, and seals, is increasingly relevant for Blockchain applications. The European Commission has acknowledged the potential of integrating eIDAS services with Blockchain technology to enhance trust and security in digital transactions across the EU. This integration aims to facilitate cross-border transactions, ensure legal certainty for Blockchain-based operations, and foster a harmonized digital single market. The ongoing evolution of eIDAS to accommodate and leverage Blockchain technology underlines the EU's commitment to creating a secure and innovative digital economy, paving the way for wider adoption of Blockchain in various sectors while ensuring compliance with increased security and authentication standards.

4.1.2 Blockchain Education & Training Initiatives

There has been substantial integration of blockchain-specific courses in higher education curricula across Europe, including university courses and degrees. For example, several European universities have introduced or expanded their course offers in blockchain technology, ranging from undergraduate modules to specialised master's programs (University of Nicosia, Politecnico di Milano, University of Malta, etc.). Courses offered tend to cover a variety of topics, including the technical aspects of blockchain, its applications in different sectors, and legal and regulatory considerations. There are also many vocational training and professional development options offered by universities, as well as other organisations. This includes short courses and certifications, particularly aiming to cater to professionals seeking to upgrade their skills or gain a comprehensive understanding of blockchain applications in their respective fields.

Online learning platforms and Massive Open Online Courses (MOOCs) have gained substantial traction in the last few years. MOOCs and other online learning platforms provide accessible blockchain courses and training material, often free or at a low cost, and the range of content varies from basic/introductory to very advanced technical levels, therefore covering a broad audience.

Universities in collaboration with public and private sector companies have established Blockchain Competence Centers or Summer Schools, to serve as hubs for research, innovation, and training, fostering collaboration between academia, industry, and government. Some universities have set up innovation labs in collaboration with industry partners to give students hands-on experience and offer internship opportunities.



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4.1.3 Blockchain Ecosystem

Various organizations, associations, and projects throughout Europe and beyond bring together specialists, academics, researchers, and business professionals to share information and expertise in blockchain. Their position can be that of knowledge creators or that of multipliers of information. Examples include the EU Blockchain Observatory and Forum, INATBA, the European Blockchain Partnership, European Blockchain Services Infrastructure, the EU Blockchain Regulatory Sandbox, and Blockchain4Europe. These ecosystems and community networks promote growth in the blockchain startup and business landscape.

4.1.4 Challenges and Opportunities

In 2023, the state of the blockchain industry in the EU proved complex but promising. The potential for innovation, public sector evolution, and sustainable development outweighed the challenges, that involved regulatory alignment, technological constraints, and skills shortages. The EU was able to steer through these obstacles and seize the opportunity to establish itself as a leader in the global blockchain field.

Some of the challenges faced in 2023 include the misalignment of legislation among Member States, which impedes cross-border blockchain applications. Blockchain networks' scalability, speed, and energy efficiency posed significant challenges to widespread adoption of the technology as well. In addition, the skills gap, and the need for workforce development in blockchain technology remains a challenge.

Several areas of opportunity were salient in the EU blockchain sector in 2023. There was substantial innovation potential in financial services - in DeFi, asset tokenization, and digital currencies – that might transform the sector and bring about greater efficiency and transparency. Significant transformational prospects were also seen in the public sector, as blockchain technology offered better service delivery in domains like voting systems, identity verification, digital product passports, micro-credentials, etc. Cross-border cooperation between the EU and its partners provided opportunities to further standards



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and interoperability, which in turn supported a strong global blockchain ecosystem. Furthermore, the creation of ethical and sustainable blockchain solutions complying with environmental and ethical requirements set by the EU creates opportunities for the responsible use of the technology. Finally, more funding for R&D from the public and private sectors aims to accelerate technological progress and encourage creative use in a range of industries and sectors.

4.2 Changes in Education and Training Provision

ECQA coordinated the conduction of interviews by CIMEA, ACQUIN and YPEPTH with education and training providers and political stakeholders in CHAISE partner countries. Interviews were conducted with 7 participants from Germany (4), Greece (2) and Italy (1), either via roundtable interviews or one-on-one. Participants were asked questions relating to trends in blockchain training provision, student enrolment and changes in VET and tertiary systems.

4.2.1 Primary Findings

Interviewees were asked about blockchain training needs and skill gaps. In general, interviewees agreed on the existence of asymmetry between education and industry in terms of blockchain skills, such that demand for blockchain skills was currently not being met by supply. They stated that education and training offers relating to blockchain skills should increase (particularly at the postgraduate level) to meet the demands of the labour market in Europe.

Interviewees were also asked about trends in enrolment in blockchain programmes. They highlighted the need to inform both employers and prospective employees about the capabilities of blockchain/distributed ledger technologies, agreeing that misconceptions relating to the technology persist among educators, business and the general public. This could be a potential source of demand suppression for enrolment in blockchain courses. That said, some interviewees observed trends of increasing enrolment in blockchain programmes. They expected these trends to continue into the near future (i.e. 5 or 10 years from now). Interviewees also reported that enrolling students typically come from technical backgrounds – engineering, computer science, mathematics – though some also come



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from business-focused disciplines (e.g. management). Interviewees characterised interested learners as having taken a personal interest in the technology, and usually having some pre-acquired knowledge when entering into programmes.

Interviewees commented on the nature of current challenges to facilitating blockchain education. They cited less-than-adequate pre-obtained technical knowledge in learners as a hindering factor to course accessibility. Alongside this, the marked diversity in competency of those interested in blockchain courses was noted, meaning it was difficult for educators to tailor courses at the appropriate level of difficulty.

Interviewees were asked about VET and Tertiary Systems. Interviewees recommended closer collaboration between industry and education to improve symmetry between the needs of employers and course content with regard to blockchain. They cited that adoption of blockchain technology was a key factor in influencing changes in educational programmes.

4.3 Economic and Policy Developments

DIGITALEUROPE undertook desk-based research to characterise economic and policy trends in blockchain skills in 2023. DIGITALEUROPE consulted resources published by Cedefop to complete this task. In 2023, the importance of diverse supply of blockchain skills was highlighted. Data from Cedefop (WIH-OJA NLP 2022) outlined the distribution of online job advertisements mentioning blockchain by sector in 2022: 27% in professional, scientific, and technical activities, 24% in information and communication, 15% in financial and insurance activities, 13% in administrative and support service activities, with smaller percentages in wholesale and retail trade (2%), manufacturing (3%), other sectors (9%), and arts, entertainment, and recreation (7%) (CEDEFOP, 2023). This stressed sectoral diversity in demand for blockchain skills, thereby calling for requisite supply across sectors.

While not explicitly related to blockchain technology, the increasing rate of digitalisation of occupations may be a key driver of demand for blockchain skills across sectors, which may lead to skills mismatches



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within certain occupations. The results of CEDEFOP's second European Skills and Jobs Survey (conducted in 2021) show that 52% of EU adult workers need to develop their digital skills further to improve their job (CEDEFOP, 2022). This policy brief points towards clear significant inequalities in training access and intensity. This shows existing disparities in training access and intensity across the EU, despite the growing demand for digital skills, including those related to blockchain technology.

On investment, while the EU has initiated the European Blockchain Partnership and the European AI/Blockchain Investment Fund, it still falls short in AI and blockchain investment due to underinvestment from both companies and governments. Europe accounts for only 7% of annual equity investments in AI and blockchain, compared to 80% between the United States and China collectively. According to a report conducted by the European Commission and the European Investment Bank, the EU needs to increase investment to respond to the estimated €10 billion investment gap (European Investment Bank, 2021).

4.4 Blockchain Labour Market Developments

EXELIA collected information from CHAISE partner countries pertaining to 1) blockchain job vacancies, 2) blockchain education and training courses and 3) blockchain use cases. These data were collected with the intention of characterising the current state of blockchain vacancies, E&T offers and use cases in more detail.

Job vacancies and E&T offers of are categorised based on their consistency with three general blockchain roles: blockchain managers, blockchain architects and blockchain developers. Blockchain developers are generally technical roles and are typically focused on solving technical problems at a micro level. Blockchain architects are responsible for the design of blockchain systems and software landscape, managing multiple aspects of broader blockchain projects. Blockchain managers are responsible for ensuring that technical processes are translated into meaningful business solutions (CHAISE, 2023). The rationale behind this categorisation is that it can help to obtain a more accurate picture of the rapidly evolving labour market, identify the most in-demand skills sought after by employers and better understand market dynamics.



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4.4.1 Blockchain Job Vacancies

In total, 84 online job vacancies from LinkedIn were collected by CHAISE partners⁸ in January 2024 and analysed by EXELIA. Of these, 54.8 percent (46) were categorised as coming from the ICT sector and 21.4 percent (18) were classified as coming from the financial services sector. The remaining 24.8 percent of the sample were classified as coming from a range of other sectors.⁹ Blockchain developers were the most frequently sought occupational category (47.6 percent of the sample), followed by blockchain managers accounting for 42.9 percent and blockchain architects accounting for 9.5 percent.

In general, most blockchain vacancies were offered at the Mid-Senior Level (42 percent), followed by Senior Level (18 percent), Mid-Level (14 percent) and Entry Level (11 percent). Approximately 15 percent of the vacancies in the sample did not have a specified level of seniority. Compared to the figures published in last year's CHAISE Blockchain Skills Forecasting report, this year's sample features a substantially larger in-sample proportion of offers at the Mid-Senior/Mid-Level (64 percent collectively this year compared to just 28 percent last year) and a consequently smaller proportion for Entry-Level/Unspecified positions (26 percent collectively this year compared to 46 percent last year) (McGuinness *et al.*, 2023). This could reflect a greater emphasis on demand for more experienced professionals over graduates.

Minimum qualification requirements and experience were also analysed. Of the 84 vacancies in the sample, 29 (34.5 percent) required a bachelor's degree, while 20 (23.8 percent) required a master's degree. Notably, 20 (23.8 percent) also required no formal degree qualification at all. It could be the case firms seeking blockchain skills do not necessarily require formal education and may place more emphasis on skillsets of blockchain professionals. However, it is not possible to determine preferences (i.e. between qualifications and skills) based on this data alone. Most blockchain vacancies (31 or 36.9 percent) required at least three years of experience, though 26.2 percent of the sample required either zero to three years of experience (12, 14.3 percent) or no experience at all (10, 11.9 percent). There

⁸ Geographical coverage: France, Estonia, Slovenia, Italy, Belgium, Austria, Luxembourg, Greece, Ireland, Germany and Bulgaria.

⁹ A detailed sectoral breakdown of blockchain job vacancies is included in Table 4A in the Appendix (Section 7.1).



are two possible explanations for this. First, the fundamental requirements for blockchain positions may not call for a lot of (if any) experience. Second, firms could be reducing the formal experience requirements of blockchain positions in response to an absence of experience in the labour market to entice as many applicants as possible. It is not possible to determine the extent of either of these potential phenomena from this data alone.

The skill requirements of job vacancies were also analysed. The three most requested technical skills in the sample were 1) Coding (C++, Python, Java), 2) Blockchain Solutions Design and 3) Data Analysis. These skills were present (either individually or together) in at least thirty percent of the entire sample. These skills were only slightly more common than Development of Decentralised Applications (28.6 percent), Smart Contract Development (28.6 percent) and Cryptography (27.4 percent). The five most requested business skills were 1) Product Development, 2) Business Needs Analysis, 3) Product Management, 4) Business Development and 5) Blockchain Use Cases Development. These skills were notably more common than other listed business skills, suggesting a strong preference across the sample for these five skills over others. Communication, Teamworking and Decision Competence were among the most popular transversal skills requested in the vacancy sample, with all three skills appearing in over half of the vacancies studied.

The technical skills that are rising in importance as compared to the previous year's report are "Coding (C++, Python, Java)", "Data Analysis", "Cryptography", "Distributed Network Engineering Skills" and "Data/Network Security". The business skills that have registered an increase in demand from the previous year are "Product Development skills", "Business Needs Analysis" and "Finance and Controlling skills". The transversal skills that have received greater attention from recruiters are "Decision Competence & Responsibility-Taking", "Critical thinking & Self-Reflection", "Ethical Competence" and "Learning literacy & Metacognitive Skills" (McGuinness *et al.*, 2023).

4.4.2 Blockchain Education and Training Offers

EXELIA analysed a sample of 94 education and training offers provided by 8 CHAISE partners from their respective EU-27 countries. Approximately 45 percent of the E&T offers in the sample were



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targeted at blockchain managers, with 31 percent intended for blockchain developers and 24 percent intended for blockchain architects. In addition, E&T offers were analysed with regard to their European Qualifications Framework (EQF) level. Of the 94 courses analysed, 43 were offered at EQF Levels 1-4 (Beginner), 34 were offered at Levels 5 and 6 (Intermediate), and 17 were offered at Levels 7 and 8 (Advanced). There was noticeable diversity in certification type. The table below provides a decomposition of the sample on the basis of certification type.

Certification Type	N	%
Master's degree	17	18.1%
Bachelor's degree	3	3.2%
Vocational Training / Professional Diploma	6	6.4%
Certificate of Continuing Education	11	11.7%
Certificate of Attendance	3	3.2%
Certificate of Completion	20	21.3%
Other	2	2.1%
Not Specified	32	34.0%
Total	94	100.0%

The two most reported certifications were Certificate of Completion and Master's degree, collectively accounting for almost 40 percent of the sample. That said, it's important to recognise that 34 percent of the sample did not have a specified certification type, meaning it is difficult to draw substantive conclusions from the diminished sample. Regarding mode of delivery, most courses in the sample were offered as online courses (44, 47 percent), with 31 percent being offered as Higher Education courses. The majority of courses offered had some online component – 35 percent were offered entirely via distanced learning, while blended learning – being the combination of both on-site and distanced learning – accounted for 27 percent of the sample.

The field of study of these E&T offers was also analysed. Most courses were classified as belonging to the Computer Science and Informatics field (30, 32 percent), followed by Business (17 percent), Finance (16 percent) and Interdisciplinary (10%). This highlights the emphasis of courses on providing both technical skills via computer science-related courses and transversal/business-focused skills. The full field of study decomposition is included in the table below.



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Table 11: E&T Offers by Field of Study

Field of Study	No. of Offers	%
Computer Science & Informatics	30	31.90%
Business	16	17.00%
Not Specified	16	17.00%
Finance	15	16.00%
Interdisciplinary	9	9.60%
Engineering	3	3.20%
Social Sciences	3	3.20%
Personal Development	1	1.10%
Other	1	1.10%
Total	94	100.0%

4.4.3 Blockchain Use Cases

CHAISE partners collected information regarding 41 unique use cases of blockchain technology across 11 countries in Europe.¹⁰ The use cases vary with regard to their geographical scope. Approximately 46 percent of the sample operated at a national level, while 39 percent of the sample operated internationally. The sectoral composition of the sample was highly varied. The table below details the sectoral makeup of the sample.

¹⁰ Greece, Ireland, Belgium, Germany, Bulgaria, Estonia, Slovenia, Italy, Romania, United Kingdom and Switzerland.



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Table 12: Blockchain Use Cases by Sector		
Sector	N	%
Retail & Accommodation	10	24.40%
Technology	9	22.00%
Finance	4	9.80%
Healthcare	4	9.80%
Sustainability	3	7.30%
Education	3	7.30%
Real Estate	2	4.90%
Aerospace	2	4.90%
Transport	2	4.90%
Other	2	4.90%
Total	41	100.0%

Retail and Accommodation and Technology accounted for the two most frequent sectors in the sample of use cases, with the remaining use cases distributed among a variety of other sectors.

A variety of applications were reported across the sample. Just over half of all use cases were applied in the field of data management (21, 51 percent). The rest of the applications were notably less frequent, as shown in the figure overleaf.



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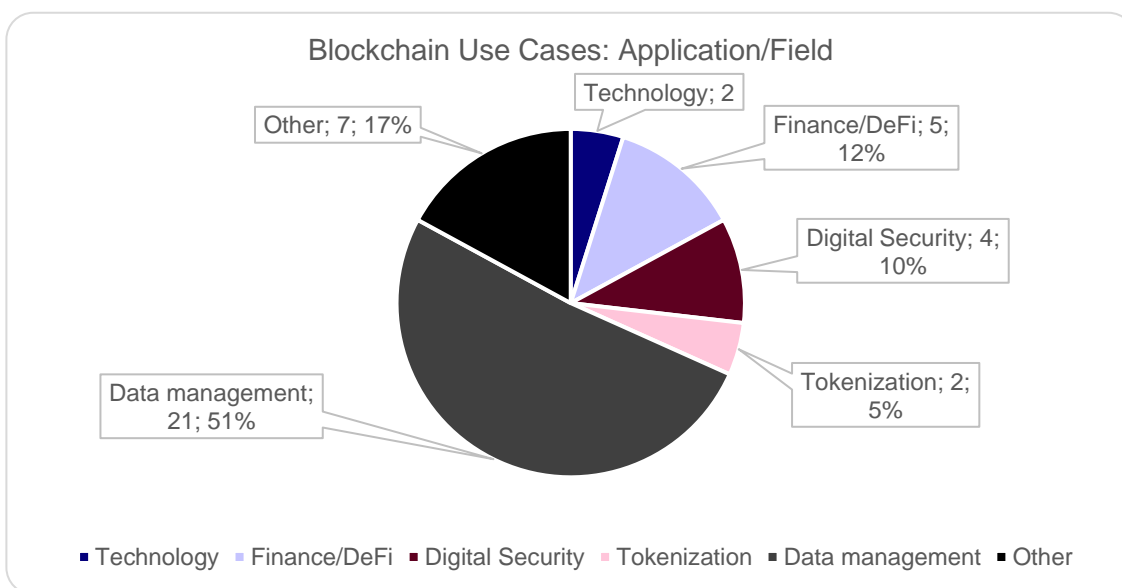


Figure 7 - Blockchain Use Cases by Application/Field

The blockchain use cases addressed a notable variety in needs. The most frequently cited needs were Data Sharing (20 percent), Transparency (17 percent), Traceability (17 percent) and Security (12 percent). Business needs were typically addressed by Tokenization (39 percent), Smart Contracts (17 percent), the implementation of Non-Fungible Tokens (NFTs; 17 percent) or a mixture of methods (27 percent).

4.5 Conclusion to Intelligence Gathering Activities

The intelligence gathering activities reveal three key aspects of the blockchain landscape in 2023. First, insights from CHAISE partners in industry reveal that regulatory misalignment is a key limiting factor for growth in the sector. With this considered, significant progress has been made in key regulatory areas in 2023 at a European level, which may provide certainty, foster innovation and promote growth in the blockchain landscape.



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Second, blockchain-focused education and training courses are seeing increasing enrolment, and provision is growing both in number and variety across Europe. While this finding is limited by the restricted profile of the interviewees, this could signal that blockchain skills supply will remain robust into the near future in Europe, which partially substantiates the findings of the forecasting exercise. This provision growth appears to be primarily driven by a particular emphasis on short, certificate-based courses as shown by the analysis of E&T offers in Europe. This could indicate that most courses are tailored to workers with more experience (short courses are more compatible with ongoing employment when compared to tertiary programmes, which require more time) which is reflective of the demands of the labour market. Despite increased E&T provision and enrolment, difficulties persist in meeting the skills demands of the labour market, which could be resolved by closer collaboration between industry and educational institutions in Europe. Furthermore, the novelty of blockchain technology means that the stock of experienced workers with the required skillset is scarce.

Finally, the demand for blockchain skills is occupationally diverse, spanning a wide range of sectors and jobs. This is reflective of the diversity in application (use cases) of blockchain technology across different sectors, as well as the findings of the forecasting exercise. While the evidence on supply is limited, the analysis of blockchain courses reveals that their focus is primarily on computer science, business and finance.



5 Verification of Results

The verification process for the forecasting results was comprised of three steps.

1. CHAISE partners conducted interviews with national field experts in CHAISE partner countries, discussing the forecasting results and receiving detailed feedback and insights. The interviews were conducted in April 2024.
2. An online survey was distributed by CHAISE partners to blockchain stakeholders in CHAISE partner countries in April 2024.
3. The Expert Advisory Board (EAB) convened in March 2024 where the forecasting results were presented and discussed.

The key findings and feedback from the verification of forecasting results are presented in the following sections.¹¹

5.1 Interviews of National Blockchain Experts

45 blockchain field experts across the EU-27 were interviewed regarding the forecasting results in April 2024. The interviews were conducted individually by CHAISE consortium partners in their respective countries on either a one-to-one basis or via roundtable interviews. Each interview included a presentation of forecasting results, followed by a detailed discussion of the key findings. The analysis of blockchain expert interviews is summarised below in four subsections: 1) Methodology, 2) Results, 3) Skill Shortages and Policy Responses and 4) Opportunities and Challenges.

5.1.1 Methodology

In general, interviewees agreed that the methodology for forecasting blockchain skills demand was appropriate. However, two issues relating to data sources used in the modelling were highlighted. First,

¹¹ Due to data changes for Ireland following the validation process, there are disparities between the forecasting figures published in this study and those presented to the EAB, interviewees and survey respondents throughout the validation process. Total forecasted demand was previously estimated to be 25,803; Graduate forecasted demand was previously estimated to be 11,347; Total forecasted supply was previously estimated to be 22,254. Given that the broader forecasting outlook remained largely the same between the two sets of figures, it was decided that further validation steps were not necessary.



many interviewees posed that LinkedIn may not be the most appropriate source of vacancy data for blockchain positions. Many interviewees stressed that many vacancies for blockchain-related positions were posted on other platforms (e.g. Telegram, Discord, F6S, Pitchbook, proprietary company websites), meaning that figures for blockchain skills demand could be underestimated. In addition, some interviewees asserted that the sole use of the keyword “blockchain” in identifying blockchain vacancies was too restrictive. Vacancies that relate to blockchain technology may often do not necessarily contain the word “blockchain” in the title or description, meaning that forecasts may be underestimated. Interviewees suggested that terms such as “distributed ledger technology” or “web3” be added to the categorisation procedure.

Most interviewees agreed that mapping to the nine ISCO 3-Digit occupational categories was appropriate. That said, some interviewees raised that there was a risk of over-generalisation, in the sense that mapping blockchain roles (which often serve to complete very specific tasks) to general occupational categories may not be useful for labour market actors due to their lack of specificity. Some interviewees also commented on a potential source of bias in the forecasts due to categorisation nuances. They posed that blockchain roles could very often be reasonably mapped to two or more of the categories listed, with very different implications for the occupational profile and size of the blockchain skills demand forecast. For instance, a vacancy could call for a mix of both technical and transversal skills, without it being immediately apparent which are more important for the role solely based on the job description. Because of this, vacancies could end up being mapped to a ‘technical category’ (e.g. ISCO 251: Software and Applications Developers and Analysts) but could be a management or business-focused role in reality (e.g. ISCO 251: Sales, Marketing and Public Relations Professionals). Because of this, mapping blockchain vacancies to one occupational category could misrepresent the true occupational nature of blockchain skills demand.

5.1.2 Results

Interviewees offered varied comments on the headline blockchain skills demand forecasts. Most interviewees thought the European figures (25,800) looked reasonable, though several others could not give a conclusive answer. Throughout all responses, two main issues stood out according to the interviewees. First, the fundamental volatility associated with blockchain technology played a role in the uncertainty surrounding blockchain skills demand estimates. Interviewees perceived that demand for blockchain skills was intrinsically volatile due to the novelty of the technology and its predisposition to



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trends within the blockchain space. Second, interviewees were generally not aware of the overall size of the blockchain sector in Europe, meaning that it was not possible for them to compare forecasting figures to information pertaining to the blockchain sector in its current state.

When asked about the finding that 44% of total blockchain skills demand was estimated to be graduate demand, responses were also varied. Some interviewees posed that this figure was believable due to the novelty of the technology and a lack of experienced professionals in the labour market with blockchain expertise, meaning skills supply could believably be largely sourced from less experienced workers (i.e. graduates). Others noted that the outsized presence of startups in the blockchain landscape could be driving the notably high proportion of demand that was graduate demand. Other interviewees felt that the estimate was too high. They cited the technical complexity of blockchain/DLTs as a barrier to less experienced workers in being sufficiently competent, meaning demand was usually in favour of more experienced workers.

Some interviewees tentatively stated that the blockchain skills supply forecasts were accurate but cautioned that underlying volatility associated with the demand for blockchain skills (discussed above) could potentially affect supply. Other interviewees could not give a definitive response to the question, citing the uncertainty of blockchain demand as an explanatory factor. Several interviewees were concerned that the accuracy of the supply forecasts may be hindered by the lack of complete data relating to blockchain graduates from CHAISE partner countries. They raised that extrapolating the average proportion of ICT graduates that had blockchain exposure to countries that could not provide the data might be misrepresentative of the broader picture of blockchain skills supply in Europe.

5.1.3 Skill Shortages & Policy Responses

All interviewees acknowledged that skills shortages had negative impacts on organisations seeking blockchain skills. Interviewees documented that blockchain-centric organisations were often required to resort to outsourcing of various processes or bid with higher salaries in order to secure talent. These effects were said to be worse for blockchain startups that often possess diminished financial resources. Because of this, it was posed that competition and output potential of the sector could be eroded. Many of the interviewees stated that skills shortages negatively impacted the development of the blockchain sector in a variety of areas. Broadly, it was proposed that shortages of blockchain skills resided in more



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experienced positions, rather than in positions suitable for graduates. Some interviewees commented on the value of experience for blockchain professionals given a shortage of such worker profiles in the current labour market. Some interviewees suggested that an existing shortage of professionals with business competencies led to a bottleneck in transforming blockchain technology into meaningful business solutions, thereby hindering wider adoption from firms. Some interviewees had experienced shortages in the areas of blockchain development and cryptography. Others pointed to a shortage of 'generalist' capabilities, such that workers could not apply their skills across different blockchain networks.

With regard to blockchain graduates, some interviewees highlighted that many blockchain courses were not fit for purpose. They explained that the rapid development in applications of blockchain technology meant that the desired skillset of a blockchain graduate was constantly evolving. Generally, tertiary courses were not deemed capable of keeping up with this dynamic skillset.

Interviewees were also asked about potential policy responses to deal with skills shortages. The most frequently suggested policy theme related to fostering closer collaboration between industry and education with regard to blockchain. This would ensure that companies' needs are met with the existing stock of graduates, while also exposing graduates to expertise and application of technical skills acquired. One participant suggested that a further emphasis on traineeships/apprenticeships in STEM degrees could be a meaningful pathway through which skills shortages could be rectified. Many interviewees endorsed a focus on targeted training programmes, though most did not make a distinction as to whether these should be tailored to graduates or more experienced professionals. Some interviewees outlined that reskilling/upskilling or lifelong learning initiatives could be particularly effective, suggesting that skills shortages were perceived to be for positions that required more experience. Alongside this, interviewees stated that a standardised skills certification for blockchain skills would greatly benefit firms and organisations seeking blockchain workers, given that current tertiary degree certifications exhibit variation in implied skillsets.

5.1.4 Opportunities and Challenges

Interviewees were asked about the main opportunities that they foresaw in the blockchain landscape over the next five years. Many interviewees pointed to the development of new use cases of the



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technology as a key area of opportunity. The translation of blockchain technology into meaningful, desirable business solutions was emphasised. Interviewees saw potential in the areas of education (through credential certification), supply chain management, healthcare, finance (digital currencies), sustainability, public administration and as a complementary technology to artificial intelligence (AI). Other interviewees cited web3 and eIDAS as specific opportunities for developers and firms to demonstrate the capabilities of blockchain technology.

Interviewees were also asked about challenges to the diffusion of blockchain technology. The challenge reported most frequently by interviewees was regulatory uncertainty. Interviewees stated that regulatory uncertainty has been a key inhibitor of the development of the blockchain landscape. Another key issue raised by many interviewees was a lack of large-scale, demonstrable use cases of blockchain technology. Many interviewees felt that this was a key factor in a lack of public trust and understanding of the technology, reducing the potential for widespread adoption. Other interviewees raised additional concerns around privacy, scalability, interoperability, environmental concerns and skills shortages as key factors inhibiting the growth of the blockchain sector.

5.2 Blockchain Skills Survey Analysis

To gather additional insights on blockchain skill developments and to review forecasting results, 91 blockchain field experts were surveyed in April 2024. The survey was disseminated by CHAISE consortium members to blockchain experts working with blockchain, such as consultants, educators, finance professionals, software engineers, economists and sales personnel. The survey contained ten questions on the validity of the CHAISE forecasting methodology, results, blockchain skill developments, and some personal characteristics of respondents. The survey results are analysed below.

5.2.1 Forecasting Results

Approximately 58% of respondents agree and 15% strongly agree with the mapping of blockchain jobs to 3-digit ISCO categories (Figure 7). Only 5% of respondents disagree and 1% strongly disagree with the mapping of blockchain jobs to the ISCO categories while 21% neither agree nor disagree.



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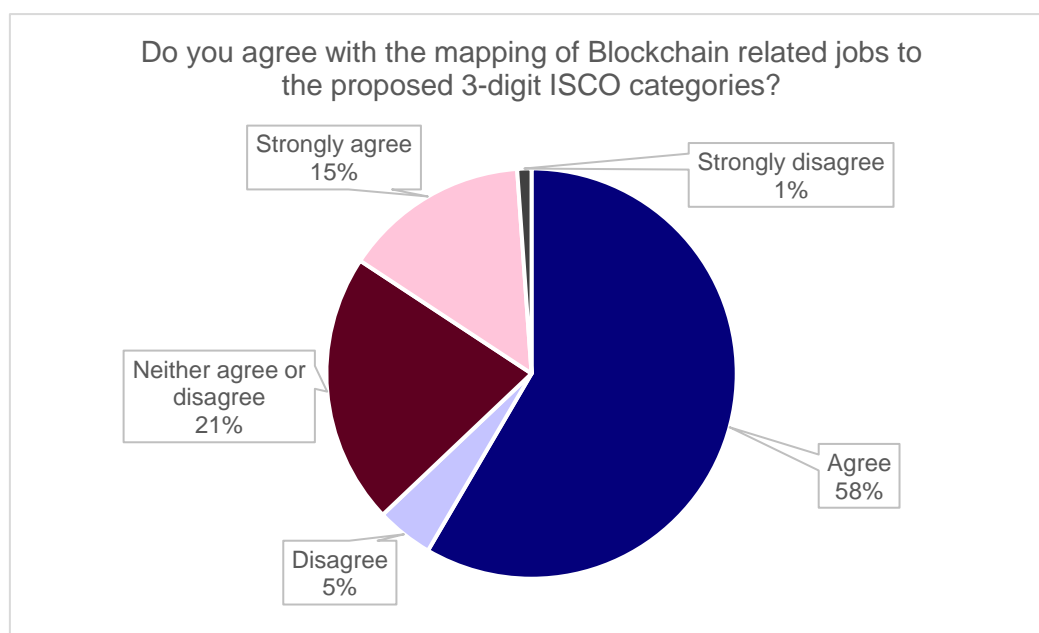


Figure 8 - Survey results from the mapping of blockchain jobs to occupational categories

Note: The complete question was, “Our results indicate that the majority of Blockchain jobs are placed into the following ISCO occupational categories: a) ISCO251-Software and Applications Developers and Analysts (43.93% of total EU Blockchain jobs), b) ISCO252-Database and Network Professionals (8.97% of total EU Blockchain jobs) and c) ISCO133-Information and Communications Technology Services Managers (8.38% of total EU Blockchain jobs). Do you agree with the mapping of Blockchain related jobs to the proposed 3-digit ISCO categories?”

Approximately 53% of survey respondents think that the blockchain demand forecasts are accurate (Figure 8). Another 24% think that demand forecasts are too low and 23% think that they are too high. When comparing survey results to the previous year of forecasting, we find that respondent views changed slightly. Last year, approximately 46% of survey respondent thought that the results were accurate, 31% thought that they were too low, and 23% thought that they were too high. It is notable that relatively less respondents deemed the forecasts too low this year, while relatively more deemed the forecasting figures accurate.



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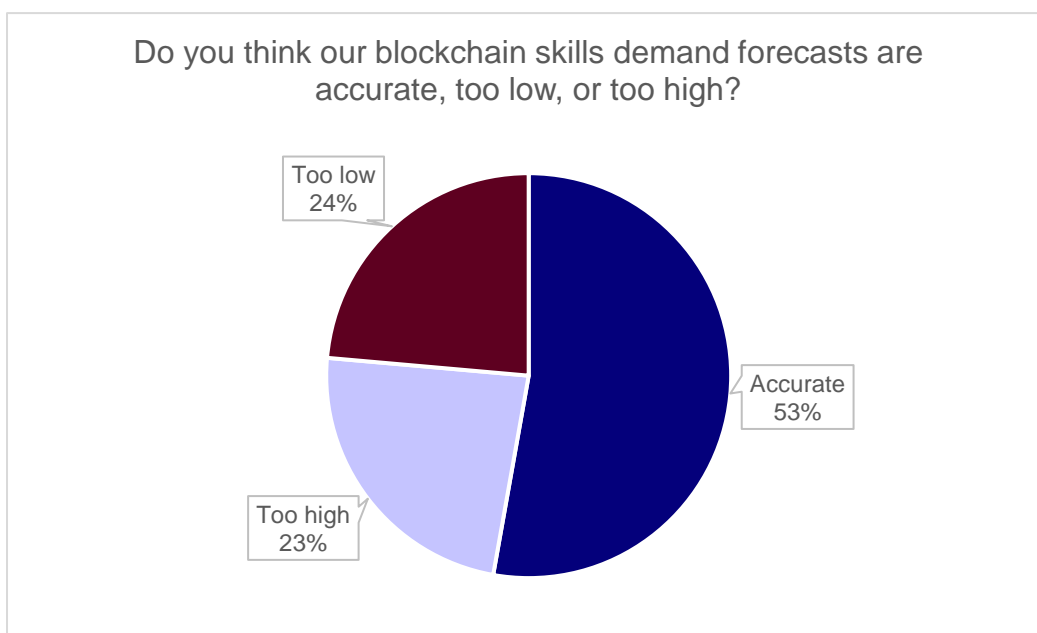


Figure 9 - Survey results from demand forecasts

Note: The complete question was, “Our preliminary Blockchain skills demand forecasting results indicate approximately 25,800 new blockchain jobs will be created from 2021 to 2026 period across Europe. Do you think these forecasts are accurate, too low, or too high?”

Approximately 63% of respondents agree with the accuracy of the blockchain graduate demand forecasting estimates (Figure 9). Additionally 17% think that they are too high and 20% think that they are too low. Last year, approximately 56% of survey respondents thought that our blockchain graduate demand forecasts were accurate, 25% thought that they were too high, and 19% thought that they were too low. Comparing these proportions gives the impression that respondents agreed more with forecasting figures published this year than last year, with comparatively less responses stating that they were too high.



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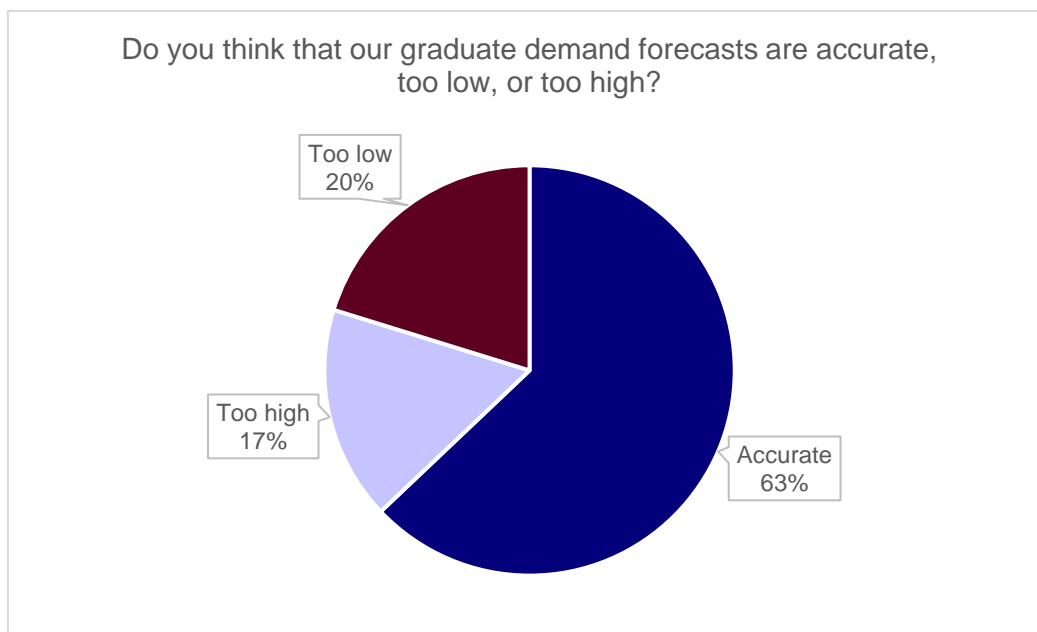


Figure 10 - Survey results from graduate demand forecasts

Note: The complete question was, “The forecasting results suggest that approximately 44% or 11,300 of new Blockchain jobs from 2021 to 2026 will be entry level or offered to new graduates. To what extent do you agree with the proportion that will be available to entry level or new graduates?”

In terms of blockchain skills supply, approximately 45% survey respondents agree and 19% strongly agree that most of the new graduates from tertiary education with blockchain exposure will come from the ICT or Computer Science fields of study (Figure 10). Another 25% of respondents neither agree nor disagree with our findings, while 5% disagree and 6% strongly disagree with the blockchain skills supply results. The nascent introduction of new blockchain courses with varied disciplines could contribute to the proportion of the survey that responded neither agreeing or disagreeing with the finding.



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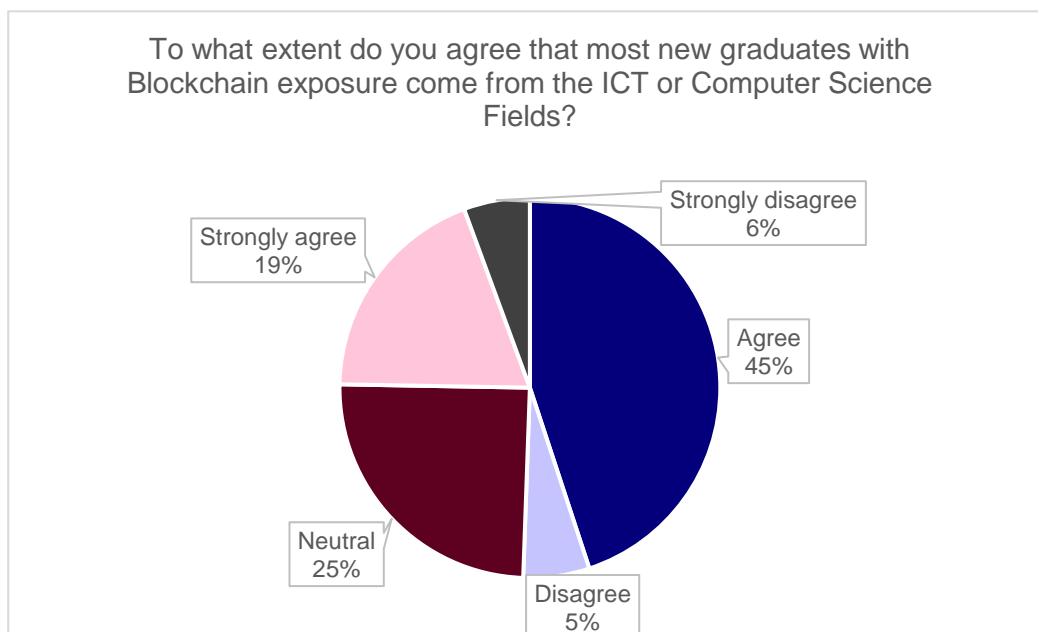


Figure 11 - Survey results from blockchain skills supply

Note: The complete question was, “To what extent do you agree that most new graduates from tertiary (higher) education with Blockchain skills come from the Information Communications Technology (ICT)?”

Approximately 61% of survey respondents agree with our forecasting results for blockchain skills supply (Figure 11). Another 25% think that they are too high and 14% think that they are too low. Last year’s survey of our blockchain supply forecasts suggested that 48% thought that our forecasts were accurate, 18% thought that they were too low, while 34% of respondents thought that they were too high. In general, respondents found this year’s estimates to be more accurate than in previous years. It is not possible to determine what the underlying drivers of this are.



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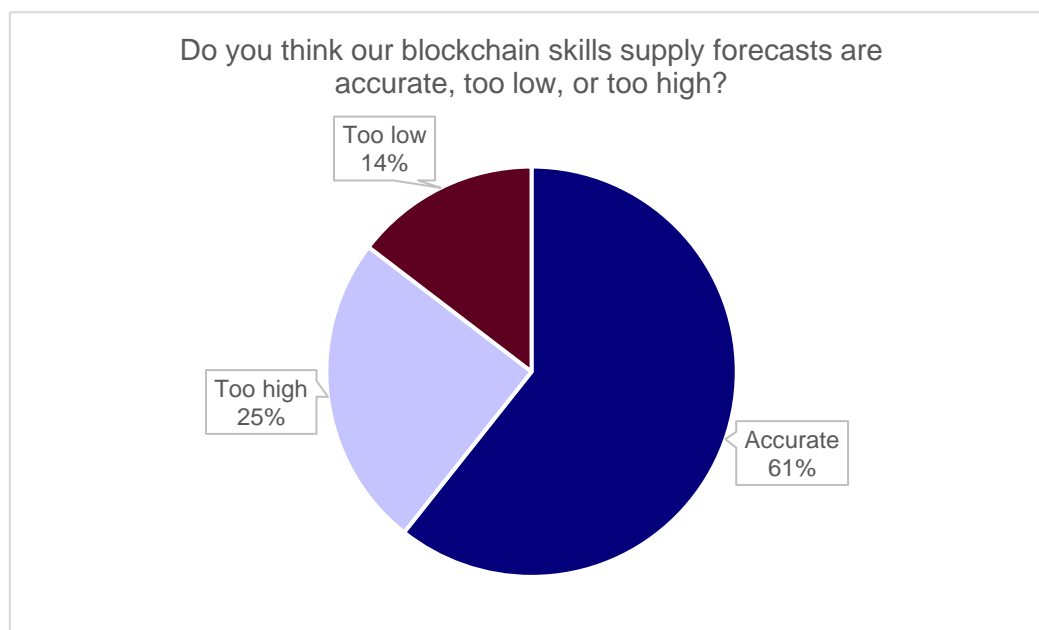


Figure 12 - - Survey results from supply forecasts

Note: The complete question was, “Preliminary Blockchain skills supply forecasting results indicate that approximately 25,500 new Blockchain graduates will be available from 2021 to 2026 across Europe. Do you think these forecasts are accurate, too low, or too high?”

5.2.2 Skill Developments

Survey participants were asked to identify what they think are the most important blockchain skills from a list of the most relevant blockchain skills currently sought after by employers. Blockchain skills were grouped in the following categories: technical skills, professional or business skills, and transversal skills. In Table 11 we show the top five most important skills identified by survey participants in each category.



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Table 13: Technical, Professional and Transversal Blockchain Skills (Survey Results)

Position	Technical Skills	Professional/Business Skills	Transversal Skills
#1	Smart Contract Development	Use Cases Development	Analytic Thinking
#2	Development of Decentralised Applications	Legal & Compliance	Communication
#3	Blockchain Solutions Design	Business Needs Analysis	Teamwork
#4	Coding (C++, Python, Java)	Product Development	Self-Determination and Autonomy
#5	Cryptography Development	Business Development	Customer Service

Note: The question was phrased as follows; "To your knowledge, what are the most important non-technical skills needed for Blockchain roles? Please select up to three (3) skills from the following list."

Smart Contract Development was identified as the most important technical skill in demand, followed by Development of Decentralised Applications, Blockchain Solutions Design, Coding (C++, Python, Java) and Cryptography Development (Table 11). Last year's survey results showed a similar interest in these technical skills, with minor changes in the ranking (McGuinness *et al.*, 2023). The results suggest that blockchain skills related to implementation and application of blockchain technology in an institutional setting continue to be in strong demand.

Professional or business skills most sought after in the sample are Use Cases Development, Legal and Compliance, Business Analysis, Product Development and Business Development (Table 11). All five of these skills were ranked in the top five positions of last year's iteration of the survey, albeit with some minor ordering differences. The development of use cases and regulatory challenges were both key limitations to adoption cited by interviewees (Section 5.1), reconciled by the top two business skills being Use Case Development and Legal and Compliance. Analytic Thinking and Self-Reflection is the most important transversal skill identified by survey participants, followed by Communication, Teamwork, Self-Determination and Autonomy and Customer Service.



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5.3 Expert Advisory Board Feedback

The CHAISE Expert Advisory Board meeting took place in March 2024 to verify forecasting results and to provide additional feedback for consideration during the project. A presentation of the headline forecasting results was given to the board, outlining the overarching goal of Work Package 3, methodological changes that had taken place since Year 2 and a discussion of the main forecasting results. Overall, the board was satisfied with the procedures and results over the latest reporting period of blockchain skills forecasting. No major adjustments to the methodology, forecasting results, intelligence gathering activities, or verification of results procedures were identified. The board highlighted that some key policy and regulatory developments – namely, the development of Electronic Identification and Trust services (eIDAS) regulation – were missing from the intelligence gathering activities presented. These sections were redrafted and included in this report (see Section 4.1).

5.4 Conclusion to Verification of Results

The field expert interviews, survey results and members of the EAB generally concluded that the methodology used to forecast blockchain skills demand and supply is appropriate. However, some concerns were raised by the field experts regarding the data sources (namely, LinkedIn vacancy data) used to operationalise blockchain skills demand. In addition, some field experts expressed concern over the accuracy of the forecasting due to underlying volatility associated with blockchain adoption, bringing with it a substantial level of uncertainty for the future of blockchain skills. Generally, the forecasting estimates were deemed to be accurate by all three components of the validation process.



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6 Conclusions and Recommendations

We employ a dynamic methodological approach to forecast blockchain skills demand and supply in the EU-27 between 2021 and 2026. This report serves as an evidence base for skills strategies and policies at a European level as they pertain to blockchain technology. The report documents the current state of the blockchain landscape in Europe, detailing the occupational and international profile of blockchain skills demand, as well as providing information on variation in blockchain application (use cases) and education and training courses.

Several key conclusions from this report are summarised below, along with recommendations for researchers conducting future forecasting exercises.

There is tentative evidence to suggest that blockchain skills demand is declining year-on-year, as evidenced by the declining share of overall vacancies posted on LinkedIn that are blockchain vacancies between 2021 and 2023. The share of vacancies that were blockchain vacancies on LinkedIn declined from 0.35 percent in 2021 to 0.23 percent in 2023. One limitation of this study is that the data do not account for blockchain vacancies on platforms other than LinkedIn. For future research, incorporating data from other online job advertisements platforms could contribute to a more comprehensive examination of trends in blockchain skills demand.

The forecasting estimates indicate that blockchain skills supply is forecasted to be sufficiently high to satisfy blockchain skills demand at the graduate level. We estimate blockchain skills demand (operationalised by online job vacancies) to be 26,837 between 2021 and 2026 across the EU-27. Of this, we estimate that approximately 43% of blockchain skills demand will be blockchain graduate demand (or vacancies suitable for graduates or entry-level positions), which equates to 11,663 vacancies for the same period. We forecast blockchain skills supply (operationalised as graduates with blockchain exposure) to be 24,415 between 2021 and 2026. Based on these forecasting estimates, we anticipate that blockchain skills supply will be sufficiently high to meet blockchain skills demand at the graduate level over this period.



One limitation is that it is not possible to determine whether demand for blockchain positions that require more experience (i.e. positions that are not entry-level) will be satisfied. This is due to a lack of available granular data on the nature of graduate skills supply (i.e. variation in course content, field of study, skills acquired) and blockchain skills supply more broadly (i.e. graduates with blockchain exposure from non-tertiary courses). This means that forecasts 1) cannot compare occupational demand with specific skills/fields of study of graduates and 2) are restricted to comparison at the graduate level. We therefore recommend the collection and implementation of more granular data pertaining to blockchain graduates (with regard to their course content), as well as investigating other sources of blockchain skills supply (i.e. that are not strictly sourced from graduates).

While forecasted graduate skills supply is sufficiently high at the European level, there is variation between countries. In some countries, we anticipate blockchain skills shortages at the graduate level (e.g. Spain, Romania, Croatia), though in most cases we forecast a surplus of graduates with blockchain exposure relative to graduate demand (e.g. France, Germany, Belgium, Denmark). It is unclear whether these asymmetries will persist, given that European workers are permitted to migrate and work in other European countries, meaning it is possible for supply shortages to be mitigated by migration.

Skills supply shortages could persist for positions requiring more experience, though quantitative evidence is lacking. A substantial number of interviewees in the validation process highlighted that blockchain employers were experiencing skills shortages with regard to experienced workers, resulting in salary inflation or outsourcing costs. Some interviewees outlined that this could have particularly punitive consequences for startups with capital constraints. This considered, a lack of substantial data documenting this specific phenomenon means that the magnitude of this issue is unclear.

Blockchain technology continues to be applied across a variety of sectors, resulting in occupationally diverse skills demand, new E&T offers and varied use cases. The sectoral profile of blockchain vacancies, use cases and education and training courses highlights this, though a notable concentration of ICT, business and finance professions and courses is reported. Insights provided from blockchain field experts and stakeholders indicate that growth (i.e. the emergence of new use cases, increases in labour demand, increased investment) is expected in the blockchain landscape in Europe



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in the medium term, which could bring about further innovation and stimulate adoption across other sectors.

Regulatory uncertainty, skills shortages and a lack of use cases and public trust in blockchain were highlighted as potential challenges for growth in blockchain adoption. Insights from industry stakeholders reveal that regulatory misalignment is a key limiting factor to growth in the blockchain sector more broadly, which may inadvertently hinder growth in demand for blockchain skills. However, it is acknowledged that progress on key legislation was made in 2023, which is set to provide clarity and dispel uncertainty for labour market actors in the blockchain landscape. This has potentially positive implications for the growth trajectory of blockchain in Europe in general, which may stimulate the demand for blockchain skills if growth is sufficiently high. Furthermore, a dearth of large-scale, demonstrable use cases with blockchain technology is cited as being a limiting factor in public understanding and trust of the technology. Stakeholders and interviewees highlighted that the onus was on 1) educators to demystify blockchain technology for the public and 2) industry to innovate and produce meaningful business solutions using blockchain technology in order to familiarise European consumers with blockchain.



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7 Appendix

7.1 Job Vacancies (Intelligence Gathering Activities)

Table 4A: Blockchain Job Vacancies by Sector		
Sector	No. of Ads	% of Sample
Information and Communication Technologies	46	54.76%
Financial Services	18	21.43%
Gaming	5	5.95%
Research	3	3.57%
Media / Telecommunications	2	2.38%
Education	2	2.38%
Construction/Engineering	2	2.38%
Cryptocurrency	1	1.19%
Consulting	1	1.19%
Recruitment	1	1.19%
Other	3	3.57%
Total	84	--

Note: Blockchain job vacancies were manually compiled by CHAISE partners and analysed by EXELIA in January 2024.



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