D2.3.1: Study on Blockchain Skills Demand

July 2021

PROJECT DETAILS

Project acronym:	CHAISE
Project name:	A Blueprint for Sectoral Cooperation on Blockchain Skill Development
Project code:	621646-EPP-1-2020-1-FR-EPPKA2-SSA-B

Document Information

Document ID name:	CHAISE_WP2_D2.3.1_ BSD_2021-07-13
Document title:	D2.3.1 – Study on Blockchain Skills Demand
Type:	Word Document
Date of Delivery:	13/07/2021
WP Leader:	DHBW
Task Leader:	ESRI
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Implementation Partner:	ESRI
Dissemination level:	Public

DOCUMENT HISTORY

Versions	Date	Changes	Type of change	Delivered by
Version 0.1	18/06/2021	Initial document	-	ESRI
Version 0.2	13/07/2021	First Revisions	Initial revisions advised by DHBW and EXELIA	ESRI
Version 0.3	13/07/2021	Second Revisions	Further revisions requested by DHBW and EXELIA	DHBW
Version 0.4	13/07/2021	Third Revisions	All Partners Reviews	DHBW
Version 0.5	21/07/2021	Fourth Revisions	Quality Assurance	UCBL
Version 1.0	21/07/2021	Final Version		ESRI

DISCLAIMER

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
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19	AKKREDITIERUNGS,CERTIFIZIERUNGS - UND QUALITATS- SICHERUNGS- INSTITUT EV	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

AF	Application Form
BC	Blockchain
D	Deliverable
DAPP	Decentralized Application
DG	Directorate General
DLT	Distributed Ledger Technology
EACEA	Education, Audiovisual and Culture Executive Agency
EQF	European Qualification Framework
EC	European Commission
EU	European Union
ICT	Information and Communications Technology
KPI	Key Performance Indicator
M	Month
MOOC	Massive Open Online Course
OER	Open Educational Resources
PM	Project Management
PMT	Project Management Team
PT	Points
QA	Quality Assurance
SC	Steering Committee
SME	Small and Medium-sized Enterprise
SSA	Sector Skill Alliance
T	Task
TL	Task Leader
VET	Vocational Education and Training
WP	Work Package
WPL	Work Package Leader

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1.0 Introduction

This report examines the labour market for blockchain skills in the European Union. The objective of the research is to establish the structure of current blockchain employment, the type of organisations employing such professionals, the educational profile of blockchain workers and the skills and competencies currently required by employers.

In this report we will analyse the market for blockchain skills using four key sources of information: (a) a literature review; (ii) the online survey; (iii) data from the registry of blockchain online job adverts; and (iv) qualitative information drawn from in-depth interviews with Blockchain companies' representatives. The market for blockchain skills will be discussed in the context of the following key themes using information from each data source:

1. Employment form and nature;
2. Blockchain workforce characteristics;
3. Skills in demand for current and future BC employees;
4. Education and skill development support;
5. Perceived changes within BC organisations.

The remainder of the report is structured as follows. Section 2 describes the methodology for the study. Section 3 discusses the relevant literature. Section 4 details the results and Section 5 summarises the main findings of the research.

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2.0 Methodology

2.1 Key Data Sources and Research Questions

The data for the study came from four key sources: (i) a literature review; (ii) an online survey; (iii) data from online job vacancies; and (d) in-depth interviews. The main features of each data source are summarised below:

- **Online survey of firms:** The online survey collected information from firms that are either currently using blockchain in their organisation or are planning to do so in the future. The dataset contains information on the characteristics of blockchain workers within firms, as well as the current and future skill and educational requirements of workers from the perspective of the employer. This EU standardised survey ran during the first half of 2021 with all partners in the study responsible for promoting the online survey in their home countries. One partner, the ESRI, had oversight responsibility for the survey. The initial survey response target was set at 520 responses. Currently 304 valid returns have been received, equating to 58% of the original target. Of the 387 firms who responded to the survey over half (52%) report as using Blockchain in some way within their organisation. The remaining 48% do not use Blockchain at present. The survey then asks those who currently do not use blockchain if they plan to in the future. Of the 185 respondents not currently using Blockchain 55% plan to in the future. 83 respondents reported not using blockchain at the minute and had no plans to, these respondents were excluded from the survey and are not included in the following analysis.

Response	Freq.	Percent
No	185	47.80
Yes	202	52.20
Total	387	100.00

Table 1 - Blockchain Usage from Online Survey

Response	Freq.	Percent
No	83	44.86
Yes	102	55.14
Total	185	100.00

Table 2 - Planned Blockchain Usage from Online Survey

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Blockchain technology is generally utilized within organisations as either providers of Blockchain/Distributed Ledger Technology (DLT) services or as users of these services. Of the 304 firms included in the analysis, 32% are primarily users of Blockchain/DLT while 47% are primarily providers. A minority (20%) utilize Blockchain as both users and providers.

Response	Freq.	Percent
Primarily users of Blockchain/DLT	98	32.24
Primarily providers of Blockchain / DLT Services	144	47.37
Both	62	20.39
Total	304	100.00

Table 3 - Primary Purpose of Blockchain from Online Survey

o **RESEARCH QUESTIONS:**

Blockchain Employee
o Can we define the term Blockchain employee?
o His/Her personal and professional characteristics?
o What are professional experiences in demand in the BC field?
o What are characteristics of professionals in demand in terms of gender & age?
o What are the requirements for the future Blockchain employee in terms of self-organisation competence, mobility, flexibility, in-house entrepreneurial skills, etc.?
o What is the future role, meaning, importance and shape of formal certification (systems) and validation of skills?

Employment form and nature
o What is the currently predominant and emerging definition of employment?
o Type of employment (employed, self-employment)?
o Type of contract (part or full time)?
o Level of wages?

Skills in Demand
o Which skills are in demand for current and for future BC employees?

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- o How do skills for BC labour mainly differ from those in other sectors? Now and in the future?
- o What is the understanding/ definition of a BC skill?
- o Which level of education/ qualification is in demand?
- o Which occupations are in demand?
- o How do occupations change?
- o How can skills in demand be categorised? (digital skills, Blockchain skills, future skills)

Education & Skill development support

- o How do (VET) education concepts need to be designed (pedagogies), structured (accessibility), organised to best support the development of BC related skills?
- o What are successful models: How can organisations and firms internally support the development of BC/ future skills (learning concepts as well as management approaches)?
- o Are there 'new work' and new leadership models going along with supporting new skill development in the BC field?
- o What are the current and successful models of organisations to develop, organise or in-source skills in demand in the BC field? (Do we need skilled workers or do we need alliances who have skilled personnel?)
- o What is the meaning and what are existing or emerging successful skill development strategies, and are these formal vs. informal vs. non-formal qualification/ education/ skill development strategies?

Change within the organisation

- o What are the currently observable and future relevant key changes coming along with the emerging BC skill demand and / or 'new work' models?
- o What are the key drivers for the perceived change?
- o What is the time prospect/ time to adopt these changes?

- **Job Advertisement Data:** The information on blockchain job adverts is used to create a unique dataset that extracts information from 338 blockchain job adverts in EU countries to help assess current employer requirements in this area in terms of, among other things, educational qualifications, labour market experience and competencies. As such, the dataset is an extremely useful source including information on important aspects of the blockchain labour market, such as the structure and composition of blockchain labour demand. One partner, Excelia, was responsible for the identification, documentation and classification of the job advertisements. The initial target

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was to collect data on 195 online job adverts, however, 314 adverts were eventually analysed and documented.

RESEARCH QUESTIONS:

Skills in Demand
- o Typical descriptions of expertise/ skills in demand?
- o Terminology used?
- o How can occupational profiles in demand be categorised on basis of the online job ads? Level of education / qualification?
- o Occupations in demand?
- o Which skills are in demand for current and for future BC employees? Skills profiles/ experiences in demand? Typology of skills in demand (digital skills, Blockchain skills, future skills)?
- o How do skills for BC labour mainly differ from those in other sectors? Now and in the future?
- o Which level of education/ qualification is in demand?
- o Which occupations are in demand?
- o How can skills in demand be categorised? (digital skills, Blockchain skills, future skills)

Future Blockchain Employee
- o Can we define the term Blockchain employee?
- o His/her personal and professional characteristics?
- o What are characteristics of professionals in demand in terms of gender & age?
- o What is the future role, meaning, importance and shape of formal certification (systems) and validation of skills for the BC profession?

Also, if possible
- o Number and Characteristics of job vacancies in BC market and in each BC Industry/ BC market segment?

- **Semi-structured interviews:** In-depth semi-structured interviews were conducted by a number of partners (DIGITAL SME, UCBL, UT, UPC, DHBW, ECQA, ITALIA4BLOCKCHAIN, UL, EXELIA) spanning a range of EU countries. The interviews were conducted with key informants, within each member state, offering key insights into the demand and supply of blockchain skills. The initial

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target of the research was to complete between 18 and 27 key informant interviews. However, 29 interviews were successfully completed.

RESEARCH QUESTIONS:

Employment form and nature
- What is the currently predominant and emerging definition of employment?
- Type of employment (employed, self-employment)?
- Type of contract (part or full time)?
- Level of wages?

Future Blockchain Employee
- Can we define the term Blockchain employee?
- His/her personal and professional characteristics?
- What are professional experiences in demand in the BC field?
- What are characteristics of professionals in demand in terms of gender & age?
- What are the requirements for the future Blockchain employee in terms of self-organisation competence, mobility, flexibility, in-house entrepreneurial skills, etc.?
- What is the future role, meaning, importance and shape of formal certification (systems) and validation of skills?

Skills in Demand
- Which skills are in demand for current and for future BC employees?
- How do skills for BC labour mainly differ from those in other sectors? Now and in the future?
- What is the understanding/ definition of a BC skill?
- Which level of education/ qualification is in demand?
- Which occupations are in demand?
- How do occupations change?
- How can skills in demand be categorised? (Technical & Blockchain Specific Skills, Professional / Business Skills, Transversal Future Skills)

Future education & Skill development support
- How do (VET) education concepts need to be designed (pedagogies), structured (accessibility), organised to best support the development of BC related skills?
- What are successful models: How can organisations and firms internally support the development of BC/ future skills (learning concepts as well as management approaches)?

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- o Are there 'new work' and new leadership models going along with supporting new skill development in the BC field?
- o What are the current and successful models of organisations to develop, organise or in-source skills in demand in the BC field? (Do we need skilled workers or do we need alliances who have skilled personnel?)
- o What is the meaning and what are existing or emerging successful skill development strategies, and are these formal vs. informal vs. non-formal qualification/ education/ skill development strategies?

Change within the organisation

- o What are the currently observable and future relevant key changes coming along with the emerging BC skill demand and / or 'new work' models?
- o What are the key drivers for the perceived change?
- o What is the time prospect/ time to adopt these changes?

- **Desk-based research on blockchain skills needs:** The approach adopted was to review the 25 most cited papers, published over the previous 18-months, on the labour market for blockchain skills. The analysis of all papers outlined in the Table below was undertaken, and completed, by one partner, Exelia.

RESEARCH QUESTIONS

Skills in Demand

- o Which skills are in demand for current and for future BC employees?
- o How do skills for BC labour mainly differ from those in other sectors? Now and in the future?
- o What is the understanding/ definition of a BC skill?
- o Which level of education/ qualification is in demand?
- o Which occupations are in demand?
- o How do occupations change?
- o How can skills in demand be categorised? (digital sills, Blockchain skills, future skills)

Future Blockchain Employee

- o Can we define the term Blockchain employee?
- o His/her personal and professional characteristics?
- o What are characteristics of professionals in demand in terms of gender & age?

o   What is the future role, meaning, importance and shape of formal certification (systems) and validation of skills for the BC profession?

Future education & Skill development support

o   What are successful models: How can organisations and firms internally support the development of BC/ future skills (learning concepts as well as management approaches)?

o   What are the current and successful models of organisations to develop, organise or in-source skills in demand in the BC field? (Do we need skilled workers or do we need alliances who have skilled personnel?)

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List of Papers Reviewed for Desk-based research component

Author	Year	Resource	Comment
Pinto	2021	Tech article	Discusses the skills needed for a blockchain developer
Medium	2020	Tech article	Finds that as blockchain has a huge number of applications there is a lack of technical understanding
Shaik	2019	Tech article	Presents top ten blockchain skills needed
Garg	2018	Tech article	Discusses gender equality in blockchain startups
Bhagat	2019	Tech article	Discusses gender equality in blockchain startups
Atherton et al.	2020	Academic publication	Focuses on the skills in demand among the Blockchain workforce in Australia
Liliana	2020	Educational article	Knowledge and skills needs for the blockchain industry
Martin	2020	Tech article	Finds public blockchains are too immature for enterprise development due to poor interoperability and scalability but foresees this changing by 2023
Capece et al.	2020	Academic publication	Looks at the importance of blockchain and the knowledge and skills needed in the industry
Deloitte	2020	Business report / Blockchain survey	Deloitte's annual 'Global Blockchain Survey 2020' studying the investment and development trends in blockchain technology
Vohra	2019	Business report	Examines skills needed in the blockchain industry
Sahebi et al.	2020	Academic publication	Sets out to present a comprehensive review of blockchain adoption barriers in the context of humanitarian supply chain management.
Kouhizabed et al.	2021	Academic publication	This exploratory study reveals interesting relative importance and interrelationships of barriers which are necessary, theoretically and practically for further adoption and dissemination of blockchain technology in a sustainable supply chain environment
Lichtigstein	2020	Tech article / Blog	Ten skills for increasing employment prospects in the Blockchain industry
Study International	2019	Tech article	Top four skill sets for those intending a career in blockchain

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Sahu	2020	Blog	This article discusses the blockchain developer skills necessary for a career in the area of blockchain.
LinkedIn	2019	Online courses on blockchain	This set of online courses provides an understanding of how Blockchain works, and what the key development skills are for beginning a new career path.
EUBlockchain Observatory and Forum	2021	Relevant Sector Skills Alliance & Sector Skills Council	May 2021 Trends Report
EUBlockchain Observatory and Forum	2018	Relevant Sector Skills Alliance & Sector Skills Council	Blockchain Innovation in Europe
Iredale	2020	Tech article	`Presents professional options in the area of blockchain across various sectors
Herman	2019	Tech article	Explains why Blockchain is becoming the most sought-after technology
EUBlockchain Observatory and Forum	2020	Relevant Sector Skills Alliance & Sector Skills Council	Discusses the situation of Blockchain in Europe and looks at key skills needed in the industry
Prewett et al.	2020	Academic publication	Discusses the barriers and risks associated with implementing blockchain technology
Steiu	2020	Academic publication	Examines the opportunities and challenges of applying blockchain in the education sector
Bhaskar et al.	2020	Academic publication	A systematic literature review on blockchain technology in education
Haugsbakken & Langseth	2019	Academic publication	Examines whether blockchain technology can be useful in higher education institutions
Sharma	2021	Tech article	Explains what blockchain is, focusing on its features and how this technology has the potential to revolutionize industries and other sectors
Naicker	2021	Tech article	Discusses how new technologies and data-driven solutions could reduce unemployment
LaborX blog	2021	Blog / Forum	Discusses new career opportunities arising from blockchain and the skills needed

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2.2 Validation of Information Sources and Findings

The results and conclusions of all data sources and information used in this study was validated by partners of the consortium (INDUSTRIA, IOTA, BERCHAIN, INTRASOFT, FUJITSU, C4A, ALASTRIA) in an organized way.[1] More specifically, the cited papers above were validated by INDUSTRIA and IOTA and in summary, their feedback suggested that the cited papers are appropriate for the needs of this task. Furthermore, they agreed that the collected information coincides with previous findings pointing towards expected strong growth over the next few years, an increase in investment and that the demand for blockchain related skills is likely to grow in the near future.

In relation to the online job vacancy data, descriptive statistics and initial summary documents were produced by the ESRI and sent to INTRASOFT and BERCHAIN. INTRASOFT validated the qualitative data on skills requirements suggesting that the collected data included what one would expect to see in such a skillset list. BERCHAIN validated the quantitative data (publication year, recruiter profile, seniority level, country, job portal, industry and job position) and were overall satisfied with the findings. However, the feedback indicated that the collected data on seniority level are not reflecting what they would expect and was possibly related to a high proportion of job adverts not specifying the seniority levels.

In relation to the European online survey, descriptive statistics and initial summary documents were produced by the ESRI and sent to C4A (to validate the quantitative data) and FUJITSU (to validate the qualitative data). C4A provided written feedback and responded to confirm that the data looked to be sensible and consistent in terms of percentage and proportion to what they would expect. FUJITSU provided written feedback which informed the report findings and responded to confirm, on average, the responses were fitting to their expectations. However, they expressed some surprise, in the complete spectrum of skills, at how dominant the technical skills are compared to the non-technical.

In addition to these individual validation stages, it is important to highlight that the collected data were not always provided in the best format in order to allow the ESRI to produce the most informative descriptive statistics. For example, in the case of the online survey, several variables were provided in long cells containing large amounts of information and we found it somewhat helpful to use a dual software approach, combining Nvivo and Stata for the analysis.

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[1] Please contact the authors directly if you wish to receive more detailed information on the specific feedback received from partners.

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3.0 Findings and Results

In this section we outline the main findings, extracted from the various data sources available to us and related to each of our identified five key themes: (i) employment form and nature; (ii) blockchain workforce characteristics; (iii) skills in demand for current and future Blockchain employees; (iv) education and skill development support; (v) perceived changes within Blockchain organisations.

3.1 Employment form and nature

In this section of the study, we are interested in examining the relevant data sources to get some idea of the form and structure of the blockchain labour market in terms of its sectoral and occupational structure. As outlined in the literature section, there is little available information profiling the structure and nature of blockchain employment.

3.1.1 Literature

Blockchain is one of the world's fastest growing industries. According to a 2020 article (Medium, 2020) only 0.8% of the population have adopted Blockchain in some capacity but this is expected to rise to 80% within the next decade due to the wide-spread applications which it can be utilised for. According to Bloomberg, blockchain-related job postings on Linkedin increased four-fold in 2017 and are likely to continue in this upward direction for the foreseeable future (Shaik, 2019). Unfortunately, the available literature and information on employment forms and the nature of employment within blockchain industries is scarce even at an international level.

From the previous CHAISE 'Study on Blockchain Labour Market Characteristics' (Deliverable D2.2.1)[2] the most relevant ICT occupations, based on the ESCO classification, found to include blockchain employees were the following: (2512) Software Developers. The respondents also highlighted profiles such as (2513) Web and Multimedia Developers; (2519) Software and Applications Developers and Analysts Not Elsewhere Classified; and (2529) Database and Network Professionals Not Elsewhere Classified. The following occupations might also include blockchain-related skills: (2521) Database Designers and Administrators; and others such as ICT System Architect (2511.13). Furthermore, it is also worth mentioning that there is a pre-release version of ESCO classification including new occupations related directly to blockchain profile: 'Blockchain architect' and 'Blockchain developer'.

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[2] For more information, please see the following link: https://chaise-blockchainskills.eu/wp-content/uploads/2021/05/D2.2.1-Study-on-Blockchain-labour-market-characteristics.pdf

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3.1.2 Evidence from the online survey

Firms responding to the online survey were asked how many employees were in the organisation. The respondents to the survey were asked how many employees were in the organisation and results are shown in Table 4. A large majority were in firms with less than 200 employees. More than a third (34%) were in firms with less than ten employees, 22% in firms with between 11 and 50 employees and a further 13% in firms with between 51 and 200 employees. Smaller proportions of respondents are in larger firms and 6% are in firms with more than 10,000 employees.

Number of Employees	Freq.	Percent
1-10	104	34.21
11-50	67	22.04
51-200	40	13.16
201-500	26	8.55
501-1000	11	3.62
1001-5000	25	8.22
5001-10000	13	4.28
>10000	18	5.92
Total	304	100.00

Table 4 - Number of Employees from Online Survey

Figure 1 is also constructed from the online survey responses and shows the industries that responding firms are located in. As the survey respondents all indicate some degree of blockchain activity, this information allows us to gauge the main industries that employ blockchain workers. The largest industry is ICT, accounting for 114 (38%) of all respondents. The other main blockchain employing industries are financial services (13%), education (12%), research (6%) and public services (3%). The "other" industry grouping comprises 43 separate industries. Most of these 43 industries contain just a single occurrence in the data (e.g., art and culture, automotive, non-profit, tax and audit).[3] It is therefore apparent from Figure 1 that currently the blockchain intensive industries are ICT, financial services and education.

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[3] A more detailed breakdown of the 'other' category can be made available on request.

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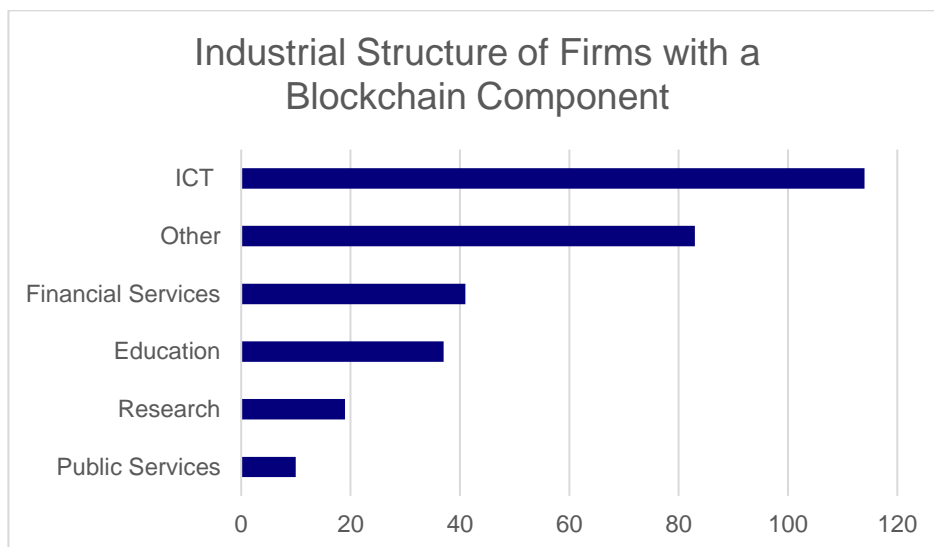
Figure 1 - Industrial Structure of Firms with a Blockchain Component

The online survey also asks firms to indicate their primary blockchain use cases. This is shown in Figure 2 below. The top three are asset transfer (92 firms, or 30%), certification (52 firms, or 17%) and business process efficiency (44 firms, or 14%). Data security is also relatively common, with 37 firms (12%) reporting this as their primary blockchain use case. The other categories are infrequent. The "other" category groups together approximately 30 individual cases that usually appear just once, such as "verifying staff credentials", "node infrastructure", "creating awareness". It also includes six "do not knows".
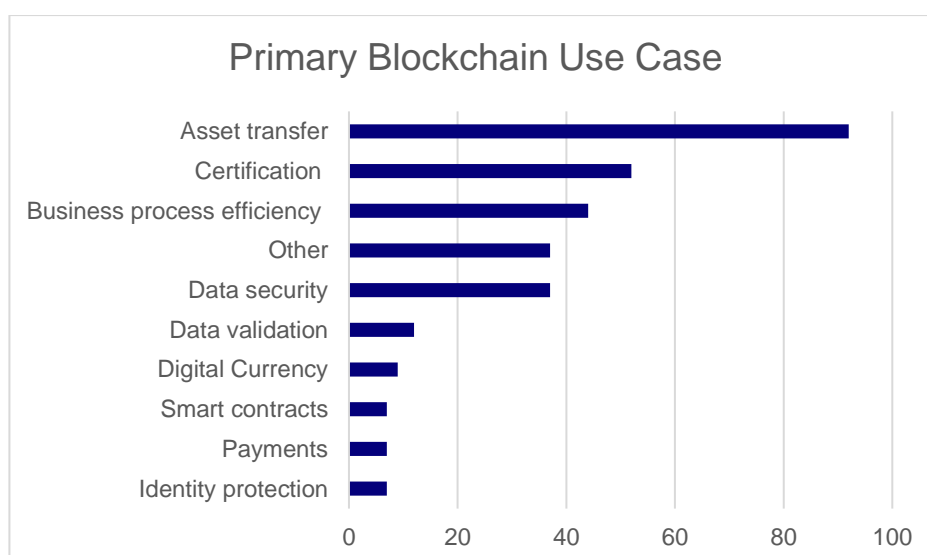
Figure 2 - Industrial Structure of Firms with a Blockchain Component

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The online survey asks the following question to respondents: "The field of Blockchain occupations or professional roles is an emerging field and changing fast. We would like to know how you in your particular context refer to Blockchain professional roles in your organisation". As the responses to this question are wide ranging, we represent them in the word cloud in Figure 3 below. The key terms mentioned are shown, with the most (least) commonly used terms represented in the clouds by the largest (smallest) fonts. Unsurprisingly, blockchain is the most common word. However, the most common terms that relate specifically to roles or occupations are: development, research, engineer, professionals, project and architect.

Figure 3 - Word cloud generated from how organisations refer to their Blockchain professionals

The online survey also asked firms "In which roles/fields do Blockchain employees work in your organisation?". Responses were not mutually exclusive; respondents could select more than one answer and are shown in Figure 4. The 5 most common answers were in roles related to product development (49%), solution architecture (48%), business development (46%), blockchain technical engineering (46%) and research (43%).

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In which roles/fields do Blockchain employees work in your organisation?
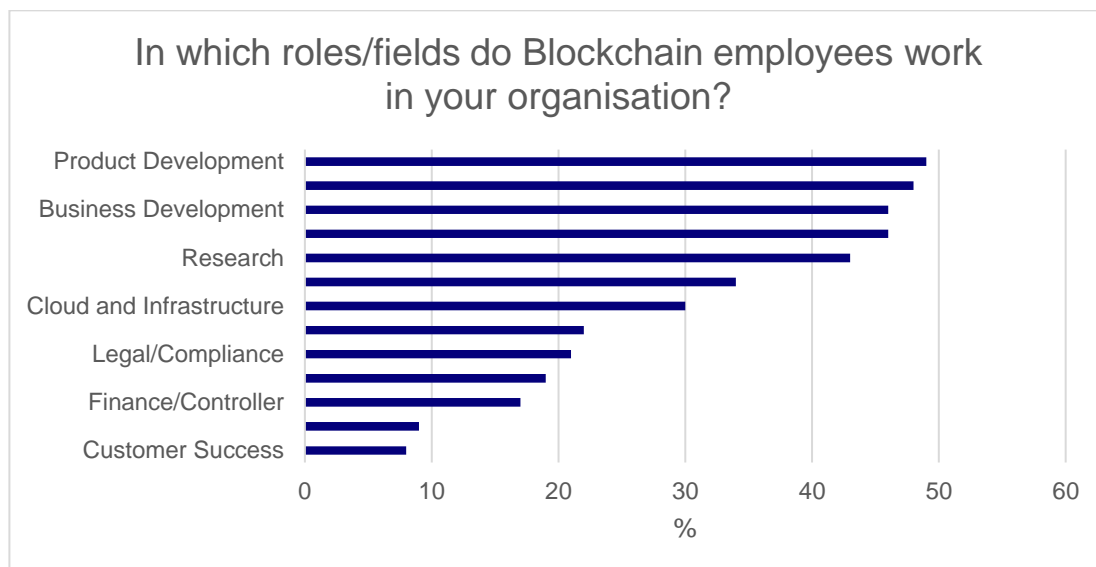
Note: N= 297; Five respondents report 'other' answers (2%) and seven missing observations.

Figure 4- Role of Blockchain employees from the Online Survey

3.1.3 Evidence from the job adverts

The data collected from online job adverts also provides an indication of the types of employers currently seeking to hire blockchain professionals (Table 5). Almost three-quarters of recruiters were blockchain service providers with a further 22 percent of hiring organisations classified as blockchain service users. The data suggests that hiring firms tend to be either service providers or users, with less than 5% of hiring firms combining provider and user activities.

Table 6 provides a detailed breakdown of the specific occupations sought by blockchain recruiters advertising on online portals. The single largest professional category sought was developers, accounting for 37% of all advertised posts. At just over 20% of all ads, Engineers accounted for the next most sought after occupation in the blockchain area. Other blockchain related occupations worth noting were consultants and managers, which accounted for 9% and 7% of job ads respectively; all other occupations accounted for a relatively small share of advertised blockchain related job ads.

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RECRUITER PROFILE	Freq.	Percent
Blockchain Service Provider	232	73.89
Blockchain Service Provider and User	10	3.18
Blockchain Service User	68	21.66
Not specified	4	1.27
Total	314	100

Table 5 - Breakdown of Blockchain Job Ads by Recruiter type

JOB POSITION	Freq.	Percent
Developer	125	37.2
Engineer	68	20.24
Other	53	15.77
Consultant	31	9.23
Manager	22	6.55
Architect	17	5.06
Analyst	8	2.38
Researcher	7	2.08
Innovation Growth Hacker	5	1.49
Total	336	100

Table 6 - Occupational breakdown of Blockchain Job Ads

The distribution of blockchain ads by country is given in Table 7 and, as such, provides an indicator of the distribution of blockchain skills demand across the EU. At 15% both Belgium and Germany accounted for the highest share of blockchain job adverts, followed by France and Italy (11% each). Thus, just 4 countries account for over 50% of all blockchain job adverts.

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COUNTRY	Freq.	Percent
Belgium	53	15.68
Germany	52	15.38
France	38	11.24
Italy	38	11.24
Greece	28	8.28
Slovenia	25	7.4
Estonia	16	4.73
Austria	15	4.44
Romania	15	4.44
Ireland	13	3.85
Spain	12	3.55
Bulgaria	10	2.96
Luxembourg	7	2.07
Other	5	1.48
Netherlands	4	1.18
Sweden	4	1.18
Denmark	1	0.3
Poland	1	0.3
Portugal	1	0.3
Total	338	100

Table 7 - Breakdown of Blockchain Job Ads by Country

Table 8 reports the distribution of blockchain adverts by online Portal and shows that Linkedin is the most dominant, with over a third of all adverts were on this platform. A further 8% of adverts were on the Indeed and Blockchain4Talent Portals, with other individual platforms accounting for relatively small shares of the total number of adverts placed.

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Job Portal	Freq.	Percent
LinkedIn	122	36.09
Other	117	34.62
Indeed	29	8.58
Blockchain4Talent	27	7.99
EURES	15	4.44
Eurojobs	15	4.44
Bamboo HR	7	2.07
Bitstamp	6	1.78
Total	338	100

Table 8 - Breakdown of Blockchain Job Ads by Portal

3.1.4 Perceptions from in-depth interviews

The majority of respondents described occupations related to the banking sector, finance, ICT, education, medical, legal, energy, and data analysis. There was much agreement that the blockchain sector is growing, with some describing it as 'absolutely booming' with 'a huge range of occupations and sectors concerned'. Some suggested that 'Blockchain is an underlying technology' and 'there is no such thing as a Blockchain employee'. It was suggested that in future there would be 'no specific focus on Blockchain but also other decentralized approaches' leading to 'decentralized system teams'. Other stakeholders stated that a key aspect of employment was to focus 'not just on particular Blockchain-related occupations, but on existing occupations that need to understand the potential of integrating Blockchain key properties (distributed traceability, trust, etc.) in products/industry sectors'.

Some emphasised how it was 'mostly still traditional job profiles' such as 'IT, legal, finance, and data experts with 'additional interests and qualifications in Blockchain and DLT'. In contrast, one stakeholder described how 'most current jobs are related to the development of blockchain-based applications' and that 'a blockchain employee is simply a web developer'. It was suggested that 'if an employee knows web development, then he can work on blockchain-based applications'. For example, typically an 'employee has knowledge of web development (such as programming skills)' and 'concepts of the blockchain (such as how to write smart contracts, knowledge of keys, and generation of hex code)'. There was however a consensus that there was a 'high demand for developers' who were 'difficult to find' along with 'expert consultants and competent teachers/trainers'.

Deliverable 2.3.1 – Blockchain Skill Demand

In sum, the majority of respondents described occupations related to the banking sector, finance, ICT, education, medical, legal, energy, and data analysis. However, it was also clearly outlined that Blockchain is not restricted to any specific field or domain. In relation to the different kind of job profiles and roles within the blockchain and DLT industry, the most commonly discussed were: project manager; consultant; business engineers; investors; combined technical and coordinating roles; blockchain software developer/technician; UX designer; legal compliance; security auditors; specialised platforms experts; and data analyst. It was also suggested that soon this list could include such titles as 'political scientist to study blockchain voting; bankers; financial analysts; accountants; artists; lawyers etc. as the technology becomes more mainstream'.

3.1.5 Summary of Findings

- The blockchain intensive industries are ICT, financial services and education.
- Almost three quarters of recruiters were blockchain service providers with a further 22 percent of hiring organisations classified as blockchain service users. Less than 5% of hiring firms combined provider and user activities.
- The single largest occupational category sought by blockchain employers was developers, accounting for 37% of all advertised posts. At just over 20% of total posts, engineers accounted for the next most sought after occupation in the blockchain area.
- The distribution of blockchain ads by country provides a broad indicator of the distribution of blockchain skills demand across the EU. At 15 % respectively, Belgium and Germany accounted for the highest share of blockchain job adverts, followed by France and Italy (11% each respectively).
- Stakeholders stated that a key aspect of employment was to focus 'not just on particular Blockchain-related occupations, but on existing occupations that need to understand the potential of integrating Blockchain key properties (distributed traceability, trust, etc.) in products/industry sectors'.
- In relation to the different kind of job profiles and roles within the blockchain and DLT industry, the most commonly discussed by interviewees were: project manager; consultant; business engineers; investors; combined technical and coordinating roles; blockchain software developer/technician; UX designer; legal compliance; security auditors; specialised platforms experts; and data analyst.

Deliverable 2.3.1 – Blockchain Skill Demand

3.2 Blockchain workforce characteristics

In this section we use the data at hand to profile the gender, education and experience levels of individuals currently employed in, or being currently recruited into, blockchain roles.

3.2.1 Literature

Data on the workforce in the industry is hard to obtain given how new and niche the industry is. However, we can hypothesize from our knowledge of the technology sector more generally that it is male dominated. Furthermore, given the newness of the technology, it is likely to be predominately younger people. A survey of blockchain start-ups in 2018 found that of 1,062 listed team members only 14.5% were women and this decreases further if senior roles or advisory positions are looked at in isolation (Garg, 2018). Other technology blogs and newspapers have also commented on the male dominance within the blockchain industry; some of this has been attributed to the gender split in technology more broadly while others have claimed it is the culture within the blockchain industry (Bhagat, 2019).

In terms of jobs advertised in Australia between September 2015 and May 2019, more than 9 in 10 required at least a Bachelor's degree and more than half required at least 3-5 years of experience. The salary for almost 60% of the jobs advertised was over 64,000 euros (Atherton et al., 2020).

From the previous CHAISE 'Study on Blockchain Labour Market Characteristics' (Deliverable D2.2.1)[4], the following patterns for the Blockchain labour market were outlined:

- **Age:** The highest percentages working in ICT and Non-ICT appear for individuals with an age between 24 and 49 years;
- **Education:** Observing the results for education, the highest percentages of people working in ICT and Non-ICT appear for high education level, followed by medium education level;
- **Gender:** A higher relative frequency for men working in ICT and Non-ICT;
- **Seniority:** entry level was the most represented level since blockchain is still a relatively new industry;
- **Experience Required:** Most of the job vacancies analysed required at least 3 years of experience, but due to the higher demand than supply of blockchain profiles, companies also accept applicants with no experience and provide them with in-house training.

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[4] For more information, please see the following link: https://chaise-blockchainskills.eu/wp-content/uploads/2021/05/D2.2.1-Study-on-Blockchain-labour-market-characteristics.pdf

Deliverable 2.3.1 – Blockchain Skill Demand

Co-funded by the Erasmus+ Programme of the European Union

3.2.2 Evidence from the online survey

Many STEM occupations are characterised as being heavily male dominated. To investigate the percentage of women in blockchain occupations, the online survey asked firms the following question, "What is the general percentage of women in your organisation working on Blockchain?" We can see from the results in Figure 5 below that two-thirds of firms (202 firms) report that under 20% of women in their organisation work in blockchain. However, we must be careful in interpreting these results. While it could indicate a gender imbalance in the blockchain workforce, it could also simply be indicative of a small number of employees in general working in blockchain within the organisation. For example, if most organisations had less than 20% of their overall employees working in blockchain activities, then even if there was gender balance, we would expect to see the result shown below. In fact, we know from the online survey that the vast majority of firms report that less than 20% of their employees work in blockchain (see Figure 6 below). Therefore, we cannot attribute the results in Figure 5 to gender imbalance in blockchain occupations.
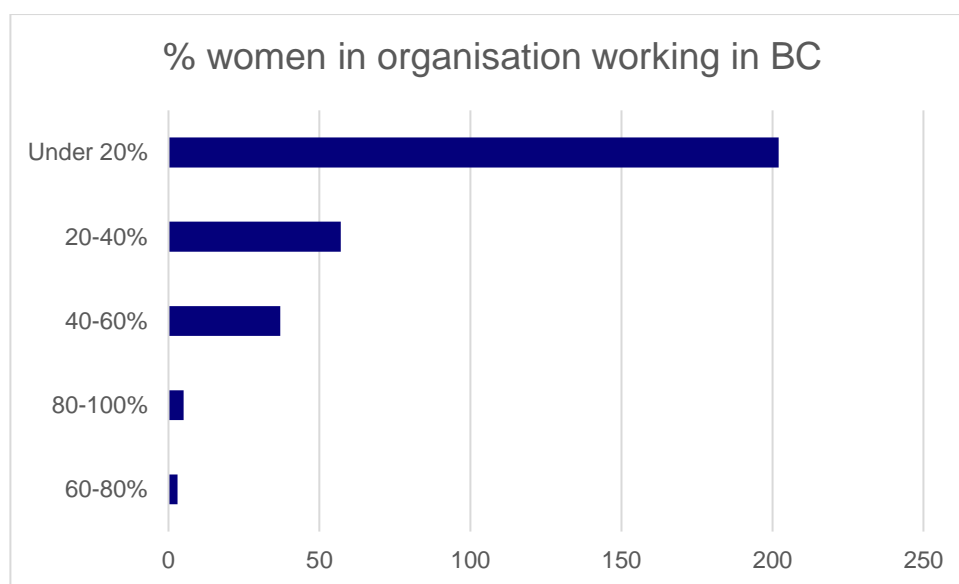
Figure 5 - Proportion of women within the organisation working in Blockchain

Deliverable 2.3.1 – Blockchain Skill Demand

% employees overall working in BC in organisation
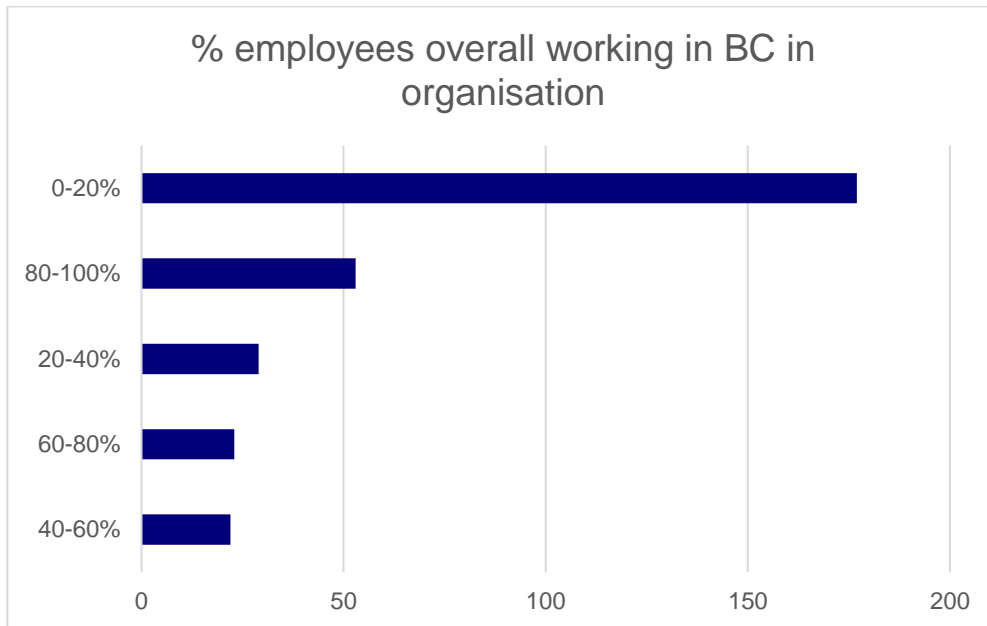
Figure 6 - Proportion of employees within an organisation who are working in Blockchain

The average age of blockchain employees within organisations is shown in Figure 7 below. It appears that blockchain employees are generally younger workers; 224 firms (74%) report an average age of blockchain employees of 35 years or less. However, it is difficult to accurately gauge the degree to which blockchain employees are overrepresented by your workers in the absence of data on the average age of employees in general, either within the organisation or within the country.

Average Age of Blockchain Employees
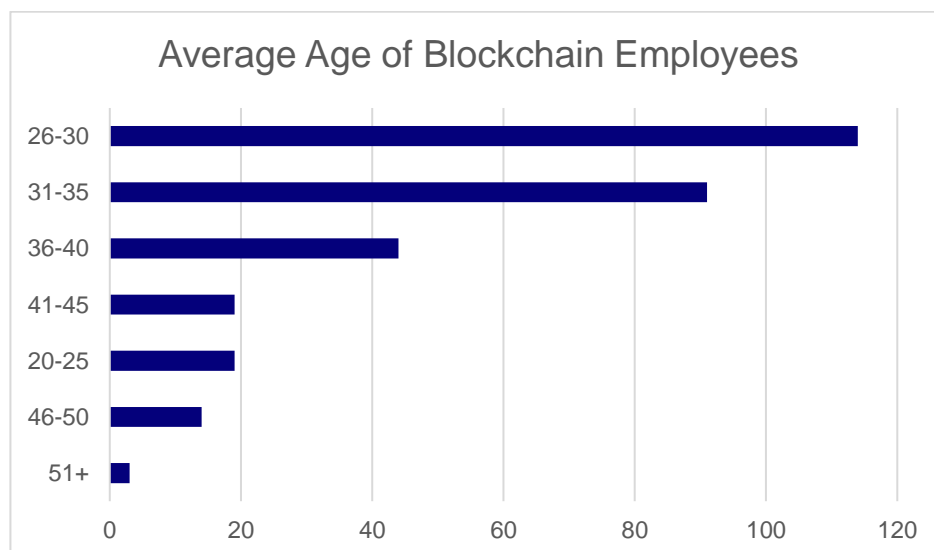
Figure 7 – Average Age of Blockchain Employees

Deliverable 2.3.1 – Blockchain Skill Demand

To ascertain the educational attainment of blockchain employees, responding firms were asked "What is the average level of education on your blockchain team?". The results are shown in Figure 8 below. Of the 304 firms surveyed, 199 (65%) reported that the average level of education of their blockchain team was a postgraduate degree. While not shown at such a disaggregated level below, if we examine the 199 postgraduate responses, we see that 22 of the 199 firms indicate PhD as the average level of education within their blockchain team. From this, it is apparent that blockchain teams are typically made up of very highly educated individuals. Figure 8 also shows that 71 firms (23%) report undergraduate degree as the average level of education, while 34 firms (11%) fall into the "other" category. Again, while Figure 8 does not show any disaggregation, we can investigate this group further. The 34 firms in the "other" category are made up of the following: vocational or diploma (6 firms); no dedicated BC team (3 firms); some undergraduate education (8 firms); no formal degree (16 firms).
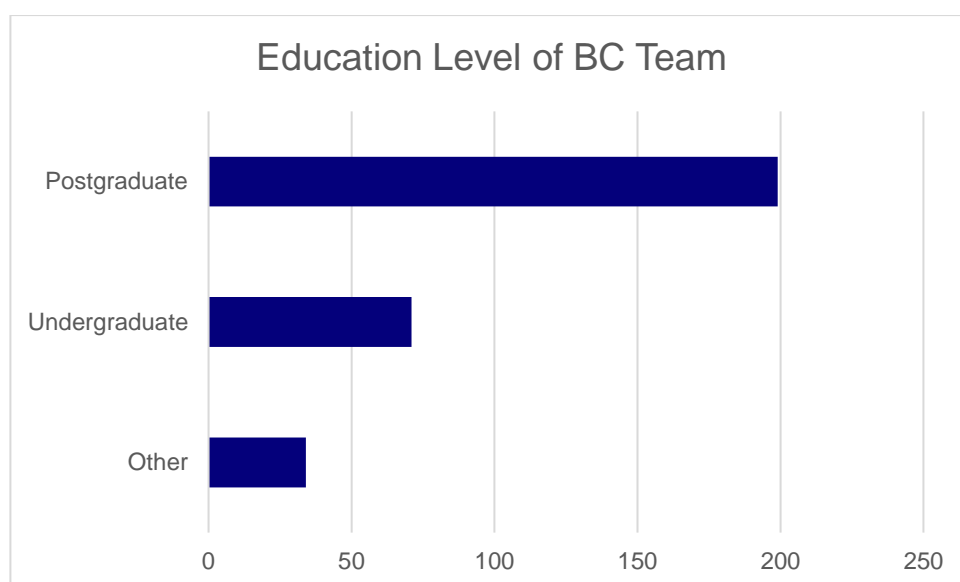
Figure 8 – Education level of Blockchain team within organisations

3.2.3 Evidence from the job adverts

We can also analyse data from the online job advertisements on the broad educational and experience profiles of blockchain workers currently in demand by EU employers. Table 9 indicates the minimum qualification level stated within the blockchain adverts. The most remarkable finding from the adverts is that, despite evidence from the online survey indicating high levels of education among existing blockchain employees, in over 40% of cases the employer did not specify a minimum educational requirement or, alternatively, stated that no formal degree was required. This indicated that for a large proportion of blockchain employers, the possession of specific professional skills and/or labour market experience is of much higher importance than academic credentials. Of all adverts, 27% had a

Deliverable 2.3.1 – Blockchain Skill Demand

bachelor's degree as a stated minimum entry requirement, while a further 23% required a master's degree. Less than 4% of adverts required a PhD, vocational qualifications or a professional diploma respectively. Table 10 provides a breakdown of the blockchain job adverts in terms of the experience levels sought by employers. Over a third of jobs appear to be open to new, or inexperienced, labour market entrants with either no, or between, 0 or 3 years' experience; however, this figure rises to potentially 52% when we also consider the proportion of adds (11.9%) with no stated experience requirements. There is a substantial demand for experienced workers in the blockchain profession, with the proportion of job adverts requiring at least 3, 5 and 8 years' experience standing at 31%, 12% and 5% respectively.

MINIMUM QUALIFICATION REQUIRED	Freq.	Percent
Bachelor Degree	91	27.33
Vocation Education Qualifications	4	1.2
Master Degree	79	23.72
No Formal Degree	57	17.12
Not specified	80	24.02
Other	1	0.3
PhD	13	3.9
Professional Diploma	8	2.4
Total	333	100

Table 9 - Occupational breakdown of Blockchain Job Ads

WORKING EXPERIENCE	Freq.	Percent
0 to 3 years	73	21.73
At least 3 years	104	30.95
At least 5 years	40	11.90
At least 8 years	17	5.06
No experience required	40	11.90
Not specified	62	18.45
Total	336	100

Table 10 - Work Experience breakdown of Blockchain Job Ads

Deliverable 2.3.1 – Blockchain Skill Demand

Table 11 categorises the advertised blockchain jobs by seniority level. Just less than 50% of jobs are at either entry level, or do not specify a seniority level, which corresponds with the analyses of job requirements based on required levels of experience (Table 10). A further 18% were classified as mid-level, 13% as mid to senior level and 22% at senior level. Finally, in Table 12 we cross-tabulate the 328 job adverts by minimum qualification requirement and job seniority level. The most significant combinations are bachelor's degree and entry level (9%), master's degree and entry level (9%), bachelor's degree and senior level (6%, master's degree / senior level (6%), and no specified qualifications and no specified seniority (6%).

SENIORITY LEVEL	Freq.	Percent
Entry Level	100	30.03
Mid Level	61	18.32
Mid-Senior Level	44	13.21
Not specified	56	16.82
Senior Level	72	21.62
Total	333	100

Table 11 - Seniority Level breakdown of Blockchain Job Ads

SENIORITY LEVEL	Bach	Mast	PhD	Voc	Prof	Not Spec	No Form	Other	Total
Entry Level	31	30	3	2	6	16	10	0	98
Mid Level	14	12	4	1	0	13	15	1	60
Mid-Senior Level	16	3	2	0	1	16	4	0	42
Not specified	7	12	1	0	0	21	15	0	56
Senior Level	21	21	3	1	1	14	11	0	72
Total	89	78	13	4	8	80	55	1	328

Table 12 - Seniority level and minimum qualification breakdown of Blockchain Job Ads

3.2.4 Perceptions from in-depth interviews

Deliverable 2.3.1 – Blockchain Skill Demand

In the qualitative interviews there was much agreement that within Blockchain and DLT there was a mix of full-time employees, part-time employees, and external freelancers (often from smaller companies). Others also acknowledged the service of 'six-month internships' and occasionally 'members of the blockchain community contributing for free'. For example, one stakeholder described how his company 'mostly have full-time employees and in-house development… [a]lso, using services of some organisations on a contract basis that provide services relevant to our project'. Another suggested that '[i]n my company, we have full-time and part-time employees. Part-time employees are students. We hire and teach them about what skills are required for building blockchain-based applications. We focus on sharpening their concepts in a specific language like Java and C#. Full-time employees are working on core projects'.

In relation to the blockchain workforce, many stakeholders agreed that the majority were typically male and under the age of 35 with one stakeholder stating that 'we mostly prefer young professionals because they have fresh knowledge of technology and can learn fast'. Some interviewees suggested that 'two out of ten workers are women', '25% are women and 75% are men' or 'the technical team is 80% male' highlighting a similar 'gender imbalance to the STEM sector'. The perception of many stakeholders was that the 'market average wage was higher than compared to other non-blockchain developers' with one suggesting a '20 per cent wage increase compared to non-blockchain developers'. While also stating that 'blockchain developers are high in demand' with 'wages varying from region to region'. The average education level was generally suggested as 'an academic degree or certificate often in computer science or informatics' combined with 'no specific experience requirement' although 'basic programming skills are required and knowledge of how blockchain works'.

It was also commonly suggested that 'since blockchain is a new technology, most required skills are often not extensively developed in employees since there is a lack of experience'. In terms of the experience level required in most cases the stakeholders discussed that 'employees do not have all ideally required skills and lack experience when starting a new post'. However, this was highly depending on the seniority of the position where '[i]n case that an employee is expected to undertake a high-level position, relevant experience will be requested'.

3.2.5 Summary of Findings

- Two-thirds of firms reported that under 20% of women in their organisation work in blockchain.
- Approximately three-quarters of firms reported an average age of blockchain employees of 35 years or less.
- 65% of surveyed firms indicated that the average level of education of existing blockchain employees was a postgraduate degree.

Deliverable 2.3.1 – Blockchain Skill Demand

- A further 23% of surveyed firms indicated that the average level of education of existing blockchain employees was an undergraduate degree.

- Despite evidence from the online survey indicating high levels of education among existing blockchain employees, over 40% of job adverts did not specify a minimum educational requirement or, alternatively, stated that no formal degree was required.

- This suggests that for a large proportion of blockchain employers, the possession of specific professional skills and/or labour market experience is of much higher importance than academic credentials.

- Over a third of jobs appear to be open to new, or inexperienced, labour market entrants with either no, or between, 0 or 3 years' experience; rising to 52% when we also consider the proportion of adds with no stated experience requirements.

- There is also a substantial demand for experienced workers in the blockchain profession, with the proportion of job adverts requiring at least 3, 5 and 8 years' experience standing at 31%, 12% and 5% respectively.

- In the qualitative interviews there was much agreement that within Blockchain and DLT there was a mix of full-time employees, part-time employees, and external freelancers (often from smaller companies).

- In relation to the blockchain workforce, many stakeholders agreed that the majority of new empoyees were typically male, under the age of 35, qualified to degree level with no previous experience. However, the experience level required is highly depending on the seniority of the position where '[i]n case that an employee is expected to undertake a high-level position, relevant experience will be requested'.

- The perception of many stakeholders interviewed was that the 'market average wage was higher than compared to other non-blockchain developers' with one suggesting a '20 per cent wage increase compared to non-blockchain developers'.

3.3 Skills in demand for current and future BC employees

In this section we use the data to attempt to identify the types, and combinations, of skills and competencies that are important within blockchain employment.

3.3.1 Literature

Blockchain has increased in popularity exponentially in recent years and in 2020 was the most sought-after hard-skill and the second-fastest growing job area in the US labour market (Liliana, 2020). It is

Deliverable 2.3.1 – Blockchain Skill Demand

thought that by 2023 blockchain technology will be adopted in the mainstream (Liliana, 2020; Martin, 2020). Although some argue that the technology is too complex and cannot be implemented easily enough to make it readily accessible (Capece et al., 2020). Liliana (2020) finds that demand for blockchain talent increased by 2000% year-on-year in 2018 and by more than 3500% between 2018 and 2020.

Deloitte (2020) found that a lack of in-house capabilities and skills is one of the main barriers for firms with regards greater adoption of Blockchain technology. Of all major organisations, 55% view Blockchain as a strategic priority and as such are investing in the technology and the necessary staffing, yet the lack of skills available remain a persistent problem for many (Vohra, 2019). Shaik (2019), Sahebi et al. (2020) and Kouhizabed et al. (2021) also find that a lack of blockchain skills is a top issue for companies across a variety of industries when it comes to adopting blockchain technology.

Articles have presented the skills needed in the market to fill these gaps. Shaik (2019) present ten skills and habits which are required for successful integration into the blockchain market: clear understanding of business outcomes; collaboration and negotiation skills with consortiums and Blockchain as a Service (Baas); interoperability; expertise in distributed ledger technology; cross-discipline broad skills e.g. design thinking, agile, DevOps and continuous delivery; knowledge of blockchain platforms; blockchain security; an ability to simplify information; understanding of blockchain architecture patterns; and a knowledge of blockchain principles and practices (standard and ecosystems). Lichtigstein (2020), Vohra (2019), Study International (2019), Sahu (2020), Martin (2020) and Pinto (2021) also find similar skills to be important in the industry.

An academic study of the skills in demand in the Blockchain workforce in Australia finds that alongside 'hard' software engineering skills (e.g. programming languages or computer science) many blockchain-related jobs require candidates to show 'softer' skills such as creativity, communication and leadership (Atherton et al., 2020). The authors believe these demands are in response to the current challenges faced in adopting blockchain technology. Of all Blockchain job adverts, 85% required a mix of hard and soft skills. It is evident from most of the articles in the area that an understanding of the complexities of the technology are required alongside interpersonal skills. Atherton et al. (2020) put this down to the lack of information surrounding the technology which would mean those with the knowledge would have to communicate with colleagues, end-users and other stakeholders and understand the business well enough to grasp how blockchain could benefit the organisation.

Deliverable 2.3.1 – Blockchain Skill Demand

From the previous CHAISE 'Study on Blockchain Labour Market Characteristics' (Deliverable D2.2.1),[5] the finding show that in blockchain-related job vacancies, companies either directly look for skills such as blockchain developer or extend the search to ICT applicants such as software developer engineer. Furthermore, they found an increased trend of blockchain related vacancies, which are not on the development level where employees are required to have a general understanding of the technology (for example in marketing, financial department, or management). Finally, a higher demand for blockchain profiles than the current supply was reported suggesting that a possible solution was to providing more specific education and training in this field.

3.3.2 Evidence from the online survey

In this section we will analyse the skills that are in demand for current and future BC employees. We look briefly at the number of job vacancies, before turning to the importance of Blockchain skills in general within an organisation and finally looking at specific skill demand in the industry.

Firms responding to the online survey were asked about current vacancies in their organisation on the Blockchain/DLT team (Table 13). 49% had no current vacancies, 15% had one vacancy and 20% had between 2 and 5 vacancies. Smaller proportions of respondents reported larger number f vacancies in their Blockchain/DLT teams while 8% were unsure of the current vacancies in this area of their organisation.

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[5] For more information, please see the following link: https://chaise-blockchainskills.eu/wp-content/uploads/2021/05/D2.2.1-Study-on-Blockchain-labour-market-characteristics.pdf

Deliverable 2.3.1 – Blockchain Skill Demand

	Freq.	Percent
0	148	48.68
1	46	15.13
2-5	61	20.07
6-10	14	4.61
11-20	9	2.96
21-30	1	0.33
31+	2	0.66
Unsure*	23	7.57
Total	304	100.00

Note: * Answers to this question were mainly in absolute numbers. However, some free text such as 'don't know', 'unsure', 'unknown', depends on supervisor' were also entered. All are combined in the column 'unsure' here.

Table 13 - Number of Blockchain/DLT Vacancies from Online Survey

Firms responding to the survey were then asked "How important is Blockchain for your organisation in general today?". The responses are shown in Figure 9 below. We see that the majority of responding firms (217 firms, or 71%) reported that blockchain skills were either very important or somewhat important, while just 12% reported that blockchain skills were somewhat, or not at all, important. Therefore, for the vast majority of responding firms, blockchain skills are seen as a key component of the organisation.

Deliverable 2.3.1 – Blockchain Skill Demand
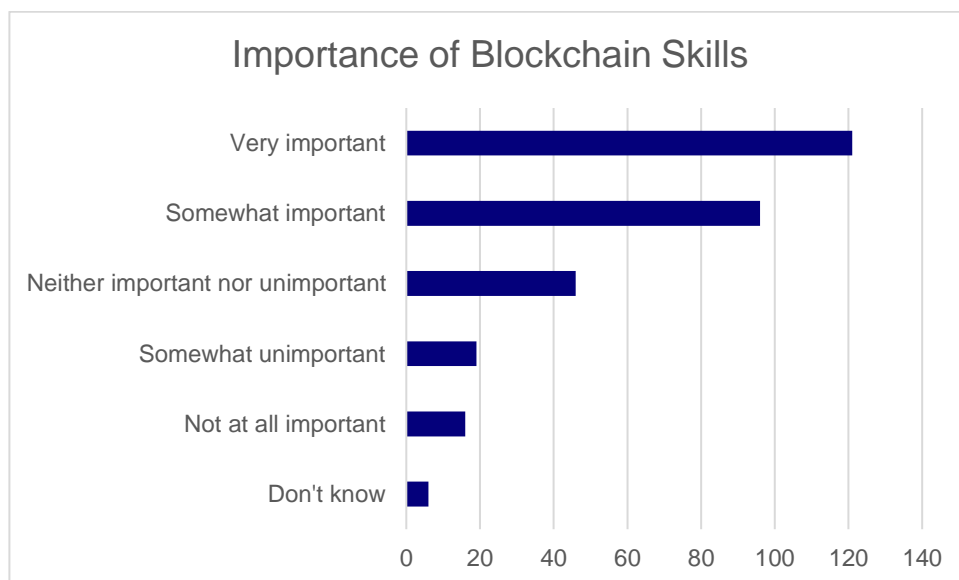
Figure 9 – Importance of Blockchain Skills within organisations

In order to gauge the types of skills that are important for blockchain employees, the online survey asked the following question to responding firms, "How do you rate the importance of transversal future skills (e.g., self-management, design competence, ethical competence, etc.) for the blockchain professional today?). From Figure 10 below, we see that the vast majority of firms (273 firms, or 90%) consider these skills either somewhat or very important. Respondents were also asked how important these skills would be for blockchain professionals within the next three years. Again, the vast majority (93%) of firms responded either very important or somewhat important (Figure 11).

Deliverable 2.3.1 – Blockchain Skill Demand
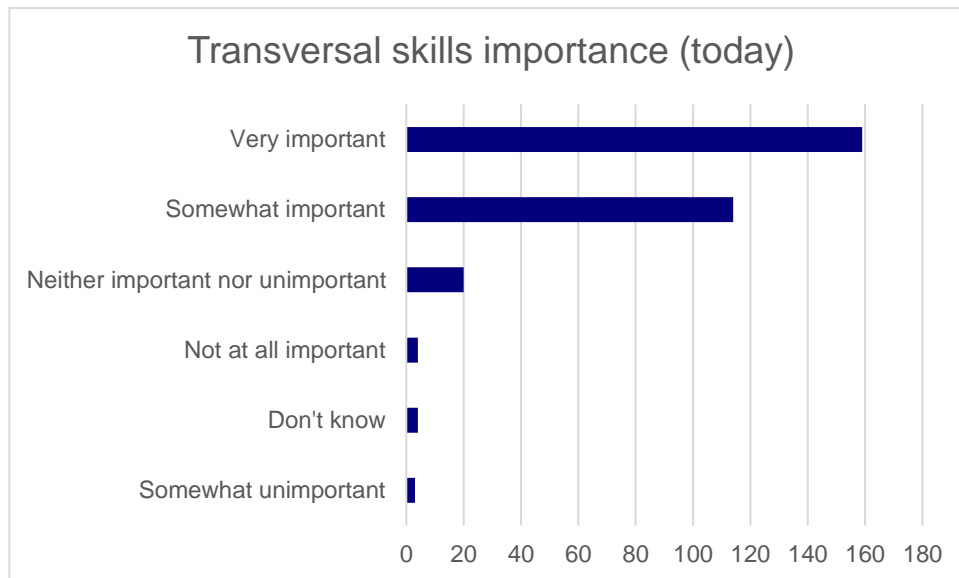
Figure 10 – Present importance of transversal skills for Blockchain professionals

Figure 11 – Importance in the next 3 years of transversal skills for Blockchain professionals

Deliverable 2.3.1 – Blockchain Skill Demand

Responding firms were also asked whether their organisation encountered any difficulties in recruiting staff with the required set of blockchain skills or knowledge. From Figure 12, we see that just over half of responding firms (155, or 51%) reported experiencing recruitment difficulties, while 20% reported no difficulties. The remaining 29% of firms either reported "not applicable" or "no, but rely on external providers". While this analysis indicates that a lot of firms have difficulties recruiting blockchain employees, we cannot disentangle whether this is due to inadequate work/contractual arrangements (e.g., pay) or whether it is due to a shortage of adequately qualified employees.
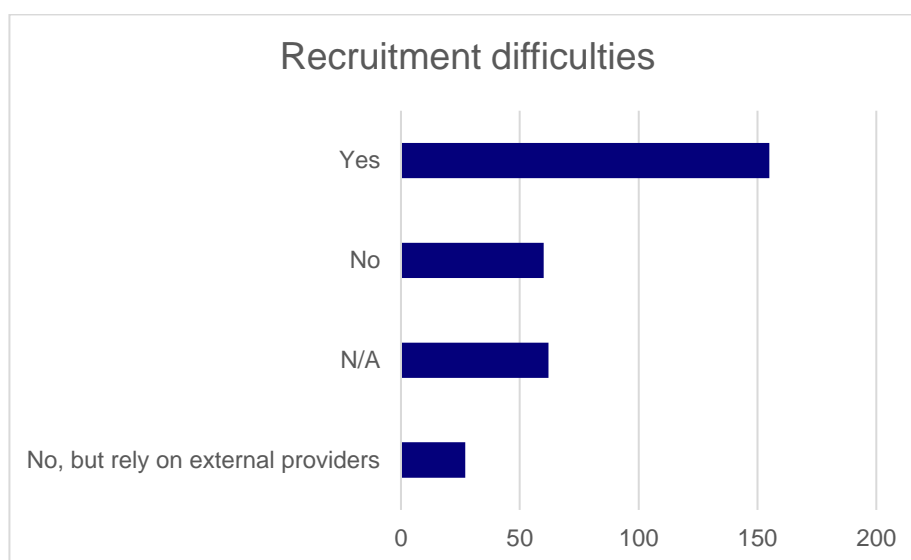
Figure 12 – Number of organisations who report as having recruitment difficulties

Firms that indicated that they experienced recruitment difficulties were asked about the main reason for these difficulties. Figure 13 shows that 75 firms (50%) indicate that there is a low number of applicants with the required skills, while 65 firms (43%) indicate a low number of applicants in general. Six firms (4%) thought there was too much competition from other employers, while 5 firms gave other reasons, including lack of freelance workers and lack of work experience.

Deliverable 2.3.1 – Blockchain Skill Demand
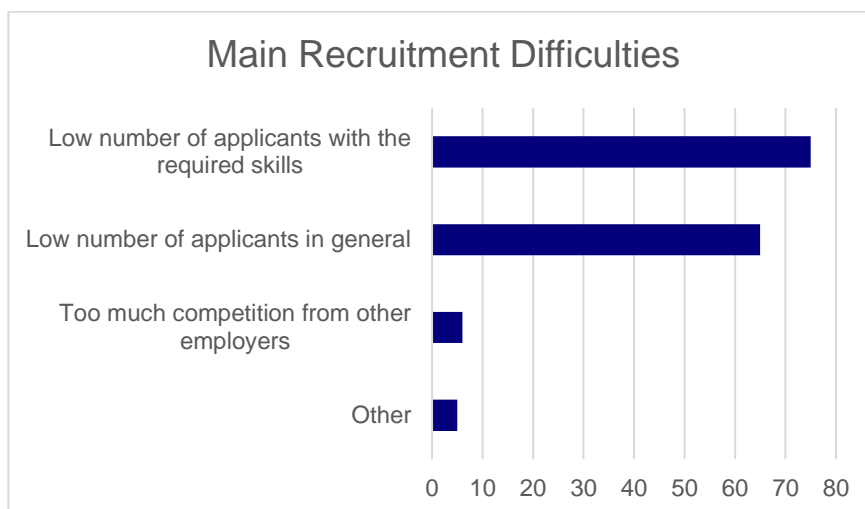
Figure 13 – The main recruitment difficulties faced by organisations

The survey went on to ask then about the skills which were deemed to be of particular importance in the Blockchain industry. Firms were asked "which of the following technical and blockchain specific skills are of particular importance" for three blockchain related job roles, results shown in Table 14. Blockchain solutions design (88%), cloud and infrastructure design (84%), data/network security design (81%), distributed network engineering skills (74%) and protocol engineering (73%) were of particular importance for blockchain architects. Coding skills (91%), frontend & backend development (87%), smart contract development (81%), development of decentralised apps (81%) and cryptography development (78%) were deemed however to be most important for blockchain developers. Technical and blockchain specific skills as would be expected are less important for Blockchain managers. However, 63% deem data analysis to be an important skill and 60% see blockchain solutions design as important for Blockchain managers. Data / Network security design (34%), Cloud and Infrastructure design (34%) and UX design (36%) were also deemed to be important for Blockchain managers.

Firms were then asked which business skills were of particular importance for Blockchain architects, developers, and managers and results are displayed in Table 15. These skills were most important for Blockchain managers with 93% of those responding reporting Business (Needs) Analysis as important as well as skills in legal & compliance matters (89%), marketing skills (88%), product management skills (88%) and business development skills (87%). For blockchain architects, skills for (Blockchain) use cases development (76%), product development skills (73%), business (needs) analysis (61%), product management skills (52%) and business development skills (42%) were deemed the most important. On

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the other hand, for Blockchain developers the particularly important skills are marketing skills (77%), finance and controlling skills (74%), human resources development skills (71%), affiliate marketing (68%) and customer success design (62%).

Firms were subsequently asked about transversal skills and their importance for Blockchain professionals (Table 16). These were important skills for all three job types. For Blockchain architects, 88% deemed innovation & creativity to be the most important transversal skills and 83% rate systems & networked thinking (analytical competence, problem solving) as important. Design-thinking competence (versatility & perspective taking) (83%), learning literacy & metacognitive skills (80%) and cooperation competence (team-working ability & emotional/social intelligence) (80%) were also seen as important skills for architects. For developers, cooperation competence (team-working ability & emotional/social intelligence) was seen as important to 83% of firms followed by self-efficacy & self-confidence (78%), communication competence (77%), self-determination & autonomy (77%) and learning literacy & metacognitive skills (75%). For those in Blockchain manager roles, communication competence was deemed to be of particular importance (92%) followed by having a future mindset & willingness to change (88%), cooperation competence (team-working ability & emotional/social intelligence) (88%), decision competence & responsibility-taking (85%) and ethical & environmental competence (85%) were all important skills for this job type.

The number of observations for the initial question on technical and Blockchain specific skills is 285, falling to 278 for the follow-up question on business skills and 270 for transversal skills which may suggest some level of survey fatigue amongst those partaking in the survey.

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Deliverable 2.3.1 – Blockchain Skill Demand

	Job Type							
	Blockchain Architect		**Blockchain Developer**		**Blockchain Manager**		**No Response***	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Maths and Stats	169	59.3	197	69.1	71	24.9	**38**	**13.3**
Coding (C++, Python, Java)	148	51.9	**260**	**91.2**	23	8.1	14	4.9
Blockchain Solutions Design	**251**	**88.1**	116	40.7	**172**	**60.4**	12	4.2
Protocol engineering	**207**	**72.6**	187	65.6	51	17.9	29	10.2
Cryptography development	163	57.2	**223**	**78.2**	37	13.0	**30**	**10.5**
Distributed network engineering skills	**211**	**74.0**	184	64.6	70	24.6	**32**	**11.2**
Frontend & Backend Development	140	49.1	**248**	**87.0**	37	13.0	20	7.0
Data Analysis	188	66.0	132	46.3	**179**	**62.8**	25	8.8
Data/ Network Security Design	**230**	**80.7**	153	53.7	**96**	**33.7**	26	9.1
Smart Contract Development	183	64.2	**232**	**81.4**	91	31.9	15	5.3
Development of decentralised apps	192	67.4	**231**	**81.1**	82	28.8	22	7.7
Cloud and Infrastructure Design	**239**	**83.9**	143	50.2	**98**	**34.4**	23	8.1
UX Design	154	54.0	157	55.1	**103**	**36.1**	**40**	**14.0**
Scientific computing	173	60.7	162	56.8	81	28.4	**56**	**19.6**
TOTAL RESPONSES	285	100.00	285	100.00	285	100.00	285	100.00

Note: The responses to this question were not mutually exclusive so the percentages horizontally or vertically will not sum to 100. From the 304 online job advertisements 19 individuals did not answer any sub-part of this question so were excluded from this analysis therefore N=285. * The no response column displays the proportion of firms who did not answer for that specific skill but did answer for some of the other skills. This can therefore be interpreted as the proportion who do NOT find a skill to be of particular importance in the industry. The top five responses for each individual job type are highlighted in **bold**.

Table 14- Which of the following TECHNICAL AND BLOCKCHAIN SPECIFIC skills are of particular importance for each of the following professional roles?

Deliverable 2.3.1 – Blockchain Skill Demand

	Job Type						No Response*	
	Blockchain Architect		Blockchain Developer		Blockchain Manager			
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Business (Needs) Analysis	**169**	**60.8**	51	18.3	**258**	**92.8**	2	0.7
Business Development skills	**117**	**42.1**	41	14.7	**241**	**86.7**	10	3.6
Skills for (Blockchain) Use Cases development	**211**	**75.9**	119	42.8	210	75.5	11	4.0
Product Development skills	**204**	**73.4**	143	51.4	199	71.6	5	1.8
Product Management skills	**144**	**51.8**	145	52.2	**245**	**88.1**	13	4.7
Skills in legal & compliance matters	116	41.7	163	58.6	**248**	**89.2**	19	6.8
Marketing skills	43	15.5	**213**	**76.6**	**245**	**88.1**	**26**	**9.4**
Finance and Controlling skills	44	15.8	**205**	**73.7**	233	83.8	**37**	**13.3**
Human Resources development skills	51	18.3	**197**	**70.9**	231	83.1	**38**	**13.7**
Customer Success design	113	40.6	**172**	**61.9**	229	82.4	**24**	**8.6**
Affiliate marketing	31	11.2	**188**	**67.6**	212	76.3	**61**	**21.9**
TOTAL RESPONSES	278	100.00	278	100.00	278	100.00	278	100.00

Note: The responses to this question were not mutually exclusive so the percentages horizontally or vertically will not sum to 100. From the 304 online job advertisements 26 individuals did not answer any sub-part of this question so were excluded from this analysis therefore N=278. * The no response column displays the frequency and proportion of firms who did not answer for that specific skill but did answer for some of the other skills. This can therefore be interpreted as the proportion who do NOT find a skill to be of particular importance in the industry. The top five responses for each individual job type are highlighted in **bold**.

Table 15- Which of the following BUSINESS skills are of particular importance for each of the following professional roles?

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	Job Type						No Response*	
	Blockchain Architect		Blockchain Developer		Blockchain Manager			
	Freq	%	Freq	%	Freq	%	Freq	%
Learning literacy & Metacognitive Skills	**217**	**80.4**	**202**	**74.8**	199	73.7	16	5.9
Self-efficacy & Self-confidence	212	78.5	**210**	**77.8**	220	81.5	18	6.7
Self-determination & Autonomy	212	78.5	**207**	**76.7**	202	74.8	**21**	**7.8**
Self-management/organisation/regulation & self-responsibility	201	74.4	198	73.3	223	82.6	20	7.4
Decision competence & Responsibility-taking	205	75.9	172	63.7	**230**	**85.2**	16	5.9
Initiative and performance competence	200	74.1	199	73.7	220	81.5	**24**	**8.9**
Ambiguity competence	183	67.8	174	64.4	220	81.5	**21**	**7.8**
Ethical & Environmental competence	178	65.9	194	71.9	**230**	**85.2**	**26**	**9.6**
Design-thinking competence	**223**	**82.6**	167	61.9	185	68.5	16	5.9
Innovation & Creativity skills	**238**	**88.1**	186	68.9	204	75.6	11	4.1
Systems & Networked thinking	**225**	**83.3**	192	71.1	150	55.6	21	7.8
Sensemaking	172	63.7	147	54.4	219	81.1	**32**	**11.9**
Future mindset & willingness to change	211	78.1	182	67.4	**238**	**88.1**	14	5.2
Cooperation competence	**217**	**80.4**	225	83.3	237	87.8	13	4.8
Communication competence	208	77.0	**209**	**77.4**	248	91.9	11	4.1
TOTAL RESPONSES	270	100.00	270	100.00	270	100.00	270	100.00

Note: The responses to this question were not mutually exclusive so the percentages horizontally or vertically will not sum to 100. From the 304 online job advertisements 26 individuals did not answer any sub-part of this question so were excluded from this analysis therefore N=270. * The no response column displays the frequency and proportion of firms who did not answer for that specific skill but did answer for some of the other skills. This can therefore be interpreted as the proportion who do NOT find a skill to be of particular importance in the industry. The top five responses for each individual job type are highlighted in **bold**.

Table 16- Which of the following TRANSVERSAL skills are of particular importance for each of the following professional roles?

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Firms were then asked about the skills which are most often missing/lacking in the industry. Again this was done by job type and by type of skill, that is blockchain specific and technical skills, business skills and finally, transversal skills.

Firms were firstly asked about technical skills, shown in Table 17. From the sample of 304 responses to the survey 61 did not answer any part of this question which may point again to an element of survey fatigue and which were excluded from the analysis. Of the remaining 243 respondents, 46% report that Blockchain solutions design was the skills most missing/lacking for Blockchain Architects. Development of decentralised apps (42%), smart contract development (38%), cryptography development (35%) and distribution network engineering skills (35%) are all skills also found to be lacking. For Blockchain developers, 50% reported that cryptography development was the skill most found to be lacking followed by smart contract development (41%), development of decentralised apps (41%), maths and stats (40%) and distributed network engineering skills (38%). For blockchain managers, the blockchain specific/technical skill most lacking is blockchain solutions design (43%), followed by smart contract development (40%), development of decentralised apps (36%), maths and stats (36%) and protocol engineering (35%).

Firms were then asked about the business skills which are found to be lacking amongst Blockchain professionals (Table 18). Of the 235 respondents to this question 48% report skills in legal & compliance matters as the most lacking for Blockchain architects. Skills for Blockchain Use Cases development (47%), business needs analysis (36%), marketing skills (33%) and customer success design (32%) were all also deemed as skills which are missing/lacking for Blockchain architects.

Skills in legal & compliance matters (45%) are also deemed to be the skills most lacking for Blockchain developers. Business needs analysis (43%), skills for Blockchain Use Cases development (42%), business development skills (40%), marketing skills (37%) and customer success design (37%) are all also deemed as the skills most lacking amongst developers in the industry.

The skill most lacking amongst managers is similar as is the case for the other job types.46% of those who answered the question reporting that skills in legal & compliance matters are lacking. Skills for Blockchain Use Cases development (44%), business development skills (32%), business needs analysis (29%) and human resources development skills (29%) are also deemed to be missing amongst Blockchain managers.

Finally, survey respondents were asked about the transversal skills which are missing/lacking (Table 19). For Blockchain architects 39% reported that decision competence & responsibility-taking were lacking followed by future mindset & willingness to change (38%), ambiguity competence (dealing with

uncertainty, acting in different roles) (37%), communication competence (37%) and innovation & creativity skills (35%).

For Blockchain developers 55% found communication competence to be lacking, followed by self-determination & autonomy (45%), self-management/organisation/regulation & self-responsibility (44%), future mindset & willingness to change (43%) and self-efficacy & self-confidence (42%). While for Blockchain managers the skill most lacking is ethical and environmental competence (41%). Innovation & creativity skills (40%), ambiguity competence (dealing with uncertainty, acting in different roles) (36%), future mindset & willingness to change (34%) and design-thinking competence (versatility & perspective taking) (34%) are also lacking for Blockchain managers.

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Table 17 - Based on your experience, which of the following TECHNICAL AND BLOCKCHAIN SPECIFIC skills are most often missing/lacking?

	Job Type							
	Blockchain Architect		Blockchain Developer		Blockchain Manager		No Response*	
	Freq	%	Freq	%	Freq	%	Freq	%
Maths and Stats	78	32.1	**97**	**39.9**	**87**	**35.8**	79	32.5
Coding (C++, Python, Java)	56	23.0	54	22.2	78	32.1	**105**	**43.2**
Blockchain Solutions Design	**112**	**46.1**	90	37.0	**105**	**43.2**	53	21.8
Protocol engineering	78	32.1	87	35.8	86	35.4	79	32.5
Cryptography development	**86**	**35.4**	**122**	**50.2**	83	34.2	66	27.2
Distributed network engineering skills	**86**	**35.4**	**92**	**37.9**	74	30.5	84	34.6
Frontend & Backend Development	52	21.4	54	22.2	73	30.0	**121**	**49.8**
Data Analysis	69	28.4	84	34.6	78	32.1	94	38.7
Data/ Network Security Design	81	33.3	74	30.5	68	28.0	99	40.7
Smart Contract Development	**92**	**37.9**	**100**	**41.2**	**97**	**39.9**	71	29.2
Development of decentralised apps	**102**	**42.0**	**100**	**41.2**	**87**	**35.8**	70	28.8
Cloud and Infrastructure Design	67	27.6	54	22.2	72	29.6	**117**	**48.1**
UX Design	68	28.0	67	27.6	74	30.5	**110**	**45.3**
Scientific computing	72	29.6	68	28.0	**84**	**34.6**	**108**	**44.4**
TOTAL RESPONSES	243	100.00	243	100.00	243	100.00	243	100.00

Note: The responses to this question were not mutually exclusive so the percentages horizontally or vertically will not sum to 100. From the 304 online job advertisements 61 individuals did not answer any sub-part of this question so were excluded from this analysis therefore N=243. * The no response column displays the frequency and proportion of firms who did not answer for that specific skill but did answer for some of the other skills. This can therefore be interpreted as the proportion who do NOT find a skill to be missing/lacking but find others are. The top five responses for each individual job type are highlighted in **bold.**

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Table 18 - Based on your experience which of the following BUSINESS SPECIFIC skills are most often missing/lacking?

	Job Type						No Response*	
	Blockchain Architect		Blockchain Developer		Blockchain Manager			
	Freq	%	Freq	%	Freq	%	Freq	%
Business (Needs) Analysis	**85**	**36.2**	**101**	**43.0**	**69**	**29.4**	72	30.6
Business Development skills	74	31.5	**95**	**40.4**	**76**	**32.3**	75	31.9
Skills for (Blockchain) Use Cases development	**110**	**46.8**	**99**	**42.1**	**103**	**43.8**	47	20.0
Product Development skills	73	31.1	84	35.7	61	26.0	**98**	**41.7**
Product Management skills	**75**	**31.9**	86	36.6	59	25.1	95	40.4
Skills in legal & compliance matters	**113**	**48.1**	**105**	**44.7**	**108**	**46.0**	56	23.8
Marketing skills	**77**	**32.8**	**88**	**37.4**	62	26.4	92	39.1
Finance and Controlling skills	73	31.1	84	35.7	57	24.3	**103**	**43.8**
Human Resources development skills	71	30.2	76	32.3	**69**	**29.4**	96	40.9
Customer Success design	**75**	**31.9**	**88**	**37.4**	63	26.8	**98**	**41.7**
Affiliate marketing	71	30.2	82	34.9	55	23.4	**110**	**46.8**
TOTAL RESPONSES	235	100.00	235	100.00	235	100.00	235	100.00

Note: The responses to this question were not mutually exclusive so the percentages horizontally or vertically will not sum to 100. From the 304 online job advertisements 69 individuals did not answer any sub-part of this question so were excluded from this analysis therefore N=235. * The no response column displays the frequency and proportion of firms who did not answer for that specific skill but did answer for some of the other skills. This can therefore be interpreted as the proportion who do NOT find a skill to be missing/ lacking but find others are. The top five responses for each individual job type are highlighted in **bold.**

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Table 19- Based on your experience which of the following TRANSVERSAL skills are most often missing/lacking

	Job Type						No Response*	
	Blockchain Architect		Blockchain Developer		Blockchain Manager			
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Learning literacy & Metacognitive Skills	61	29.2	73	34.9	66	31.6	**88**	**42.1**
Self-efficacy & Self-confidence	57	27.3	87	41.6	44	21.1	82	39.2
Self-determination & Autonomy	55	26.3	**94**	**45.0**	43	20.6	**88**	**42.1**
Self-management & Self-responsibility	66	31.6	**91**	**43.5**	46	22.0	86	41.1
Decision competence & Responsibility-taking	**81**	**38.8**	88	42.1	65	31.1	68	32.5
Initiative and performance competence	64	30.6	82	39.2	52	24.9	**96**	**45.9**
Ambiguity competence	**78**	**37.3**	87	41.6	**76**	**36.4**	71	34.0
Ethical & Environmental competence	68	32.5	73	34.9	**86**	**41.1**	83	39.7
Design-thinking competence	71	34.0	78	37.3	**70**	**33.5**	77	36.8
Innovation & Creativity skills	**74**	**35.4**	**91**	**43.5**	83	39.7	71	34.0
Systems & Networked thinking	59	28.2	62	29.7	60	28.7	**98**	**46.9**
Sensemaking	67	32.1	72	34.4	63	30.1	85	40.7
Future mindset & willingness to change	**79**	**37.8**	**90**	**43.1**	**72**	**34.4**	78	37.3
Cooperation competence	65	31.1	80	38.3	53	25.4	**93**	**44.5**
Communication competence	**78**	**37.3**	**115**	**55.0**	52	24.9	66	31.6
TOTAL RESPONSES	209	100.00	209	100.00	209	100.00	209	100.00

Note: The responses to this question were not mutually exclusive so the percentages horizontally or vertically will not sum to 100. From the 304 online job advertisements 95 individuals did not answer any sub-part of this question so were excluded from this analysis therefore N=209. * The no response column displays the frequency and proportion of firms who did not answer for that specific skill but did answer for some of the other skills. This can therefore be interpreted as the proportion who do NOT find a skill to be missing/lacking but find others are. The top five responses for each individual job type are highlighted in **bold.**

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Given the nature of the question the no-responses are also informative. Firms to the survey were asked which skills they felt were missing or lacking by various job roles. Firms who gave no response to any of the skills mentioned (i.e. did not answer any part of the technical skill sub-parts) were excluded while those who answered only for particular skills were included (e.g. five out of the fourteen technical skill parts). Not answering for a particular skill would suggest the firms did not deem this to be a skill currently missing/lacking. Frontend & backend development (50%), cloud & infrastructure design (48%), UX design (45%) and scientific computing (44%) in particular were found not to be significantly lacking (compared to the other listed skills) in the Blockchain industry in terms of technical skills (Table 17 and Figure A1). In terms of business skills, affiliate marketing (47%), finance & controlling skills (44%), product development skills (42%), customer success design (42%) and human resource development skills (41%) were found not to be lacking by a large proportion of firms (Table 18 and Figure A2). While systems & networked thinking (analytical competence, problem solving) (47%), initiative and performance competence (Self-motivation, engagement, persistence) (46%), cooperation competence (team-working ability & emotional/ social intelligence) (45%), learning literacy & metacognitive Skills (42%) and self-determination & autonomy (42%) were not reported as missing/lacking (again, compared to the other listed skills) by large proportions of firms in terms of transversal skills for Blockchain professionals (Table 19 and Figure A3).

Like the previous question the number of observations fell with each subset of questions likely due to survey fatigue. There were 243 respondents for the first subset of question 19 and then 235 respondents and 209 for the second and third subsets respectively.

3.3.3 Evidence from the job adverts

The blockchain online job advertisement information also contains important information related to the educational and skills development of the blockchain profession, as the adverts contain information on the key competencies and skills currently required by employers. The key competencies and terms mentioned within the blockchain adverts are shown in Figure 14, with the most (least) commonly used terms represented in the clouds by the largest (smallest) fonts.

In our analysis, we ranked the most common terms appearing within the job adverts and separated the required competencies into three areas; (i) technical skills; (ii) business skills; and (iii) transversal skills. The results from this initial analysis are provided in Table 20. As part of the validation process, blockchain experts were consulted to group the most common combination of terms. Thus, for example,

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"coding", "java" and "python" were the most common technical terms to appear in the adverts. Our blockchain expert identified "development", "design", "blockchain" and "solutions" as a set of competencies, during the validation process, that related and require similar skill sets. We then ranked the most commonly requested skills/competencies in each area and these are detailed in Table 21.

The key technical competencies required by blockchain employers are "coding", "engineering", "frontend", "backend" and "design". Analysis of the data revealed that 86% of adverts contained at least one of these top technical skills, 57% of adverts contained at least one of the top business competencies in Table 21 and 80% of adverts contained at least one of the listed transversal competencies. We found that 42% of adverts contained at least one of the each of the listed technical, business and transversal competencies.

Figure 14 - Blockchain Skill Competency World Cloud

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Technical Skills		Business Skills		Transversal skills	
Term	N	Term	N	Term	N
coding	227	skills	521	self	670
java	227	development	380	competence	633
python	227	product	220	thinking	263
development	221	business	156	ability	207
design	190	blockchain	141	cooperation	207
blockchain	163	cases	141	emotional	207
solutions	163	use	141	intelligence	207
data	145	analysis	77	social	207
network	115	management	77	team	207
backend	97	needs	77	working	207
frontend	97	customer	59	responsibility	200
engineering	89	design	59	communication	172
analysis	84	success	59	taking	157
applications	69	marketing	27	analytical	126
bitcoin	69	controlling	25	networked	126
decentralised	69	finance	25	problem	126
ethereum	69	compliance	22	solving	126
stellar	69	legal	22	systems	126
cloud	65	matter	22	autonomy	120
infrastructure	65	human	17	determination	120

Table 20 – Top 20 most requested terms found by skill type

Skill Type	Key Competencies and Skills Requested
Technical Skills	"coding" "engineering" "frontend / backend" "design" "bitcoin"
Business Skills	"management" "marketing" "finance" "product development" "design"
Transversal Skills	"self efficacy" "co-operation" "responsibility" "communication" "teamworking" “emotional intelligence"

Table 21 - Key Competencies and Skills Requested in Blockchain Ads

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In Table 22 we examine the distribution of the key skills identified in each area. In terms of technical skills, the most commonly requested areas were coding design with over two-thirds (67%) of all adverts requesting these. With respect to business competencies, product design and management skills were most in demand. Finally, over 50% of adverts requested teamworking and communication and teamworking / emotional intelligence skills.

Technical	%	Business	%	Transversal	%
Coding	67.16	Management	22.78	Self-efficacy	23.71
Design	51.78	Marketing	5.62	Teamworking	61.64
Engineering	20.12	Finance	7.4	Responsibility	43.79
Networking	30.18	Product Development	42.31	Communication	50.89
Front / Backend	28.7	Design	17.46		
Bitcoin	20.41	Compliance	6.51		

Table 22 - Distribution of most requested skills by competency area

In Table 23, we estimate a multivariate probit model to identify the key characteristics of adverts requesting at least one of the listed competencies in each respective area. While these models are designed to identify statistically significant patterns in the demand for the various competencies by seniority, sector, country etc., we also include descriptive tables of the relevant distributions in the Appendices. The technical skills listed most commonly appeared in adverts for developers and engineers and, unsurprisingly, were less likely in adverts for managers. Relative to other countries not listed in Table 23, recruiters in Germany and Italy were most likely to request at least one of the listed technical competencies. With respect to the most common business competencies, these were most common in firms that operated across both the ICT sector and the "other" sector category.[6] Firms seeking business competencies were much more likely to advertise on the Eures and EUjobs portals relative to Linkedin. Compared to other countries, recruiters based in Greece were much more likely to request at least one business competency in their blockchain adverts. Finally, with respect to transversal skills, these are more likely to be sought in firms operating in the intersection between ICT and another sector. Firms seeking blockchain professionals with transversal skills are more likely to advertise on the Eures and EUjobs portals and are more likely to be located in Belgium, Greece, Bulgaria and Spain.

VARIABLES	Technical	Business	Transversal

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[6] The most common combination of this in the data was ICT and Financial Services.

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OCCUPATION			
Developer	0.17***	-0.16*	-0.05
	(0.046)	(0.086)	(0.068)
Engineer	0.15***	-0.17*	0.09
	(0.036)	(0.096)	(0.062)
Architect	0.12***	0.14	0.04
	(0.033)	(0.138)	(0.099)
Consultant	-0.02	-0.11	
	(0.082)	(0.128)	
Manager	-0.20	-0.11	-0.07
	(0.134)	(0.134)	(0.132)
SECTOR			
ICT	-0.07	0.06	-0.02
	(0.067)	(0.085)	(0.066)
ICTother	-0.09	0.19**	0.16***
	(0.102)	(0.096)	(0.050)
Financserv	-0.04	0.04	-0.08
	(0.088)	(0.105)	(0.102)
JOB PORTAL			
LinkedIn	-0.11*	-0.08	0.02
	(0.060)	(0.076)	(0.059)
Indeed	-0.00	0.05	0.01
	(0.096)	(0.115)	(0.096)
BCtalent	-0.13	-0.10	0.00
	(0.127)	(0.119)	(0.093)
EURES		0.29***	
		(0.089)	
EUJobs		0.31***	0.18***
		(0.085)	(0.032)
COUNTRY			
Austria		-0.00	
		(0.194)	
Belgium	0.07	0.15	0.19***
	(0.072)	(0.126)	(0.051)

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Bulgaria	0.05	0.00	0.17***
	(0.104)	(0.205)	(0.035)
Estonia	-0.09	-0.07	-0.15
	(0.142)	(0.177)	(0.177)
France	0.01	0.08	0.21***
	(0.094)	(0.138)	(0.042)
Germany	0.10*	0.04	0.08
	(0.057)	(0.140)	(0.092)
Greece	0.08	0.43***	0.20***
	(0.062)	(0.043)	(0.036)
Ireland		0.26**	
		(0.125)	
Italy	0.12***	-0.01	-0.03
	(0.048)	(0.149)	(0.126)
Romania		0.10	
		(0.161)	
Slovenia	-0.29	-0.21	0.04
	(0.176)	(0.165)	(0.105)
Spain			0.18***
			(0.034)
Observations	250	319	255

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Table 23 - Determinants of Skill Demand in Adverts.

Deliverable 2.3.1 – Blockchain Skill Demand

Finally, Table 24 examines the key characteristics of the 43% of firms likely to require some combination of the most listed technical, business and transversal skills. Firms seeking multidisciplinary competencies were less likely to be hiring managers and were more likely to advertise on the Eures or EUjobs portals. Blockchain professionals with combinations of technical, business and transversal skills were most likely to be sought by firms located in Greece and Ireland.

VARIABLES	All Competencies
OCCUPATION	
Developer	-0.10
	(0.088)
Engineer	0.03
	(0.099)
Architect	0.14
	(0.161)
Consultant	-0.18
	(0.112)
Manager	-0.24**
	(0.107)
SECTOR	
ICT	0.05
	(0.091)
ICTother	0.17
	(0.122)
Financserv	-0.03
	(0.115)
JOB PORTAL	
LinkedIn	-0.16**
	(0.077)
Indeed	0.04
	(0.124)
BCtalent	-0.09
	(0.121)
EURES	0.42***
	(0.113)
EUJobs	0.48***

	(0.087)
COUNTRY	
Austria	0.23
	(0.191)
Belgium	0.19
	(0.146)
Bulgaria	0.20
	(0.202)
Estonia	-0.29**
	(0.136)
France	0.05
	(0.155)
Germany	0.06
	(0.151)
Greece	0.51***
	(0.084)
Ireland	0.46***
	(0.115)
Italy	-0.22*
	(0.133)
Romania	0.25
	(0.169)
Slovenia	-0.10
	(0.161)
Observations	319

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 24 - Determinants of Firms Demanding All Key Competencies.

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3.3.4 Perceptions from in-depth interviews

A major focus of the qualitative interviews was to gather opinions on the skills in demand for current and future employees. Many of the issues raised relate to the shortages of blockchain-related skills and candidates for positions. Some stakeholders highlighted that for instance 'developers and UX designers are already rare, and, as blockchain is a specialization, it makes [the Blockchain] employee rarer' and that 'when we create a hiring application, we place some skills and none of the employees fulfil the criteria'. Other stakeholders, however, differed from this view and felt that 'it was not necessary that every job requirement should be fulfilled' and 'inexperienced younger workers could easily learn within the role'.

In terms of specific skills, stakeholders were asked to discuss technical, business and transversal skills. Needless to say, 'a good understanding of computer science' combined with 'the basic concept of how Blockchain works' was often highlighted as essential. In relation to technical skills, the most commonly discussed skills included knowledge of: Blockchain platforms, IT, algorithms, programming languages (Python, solidity language, C, C++, Java, etc.), software development, software architecture design, frontend/backend development, P2P network and multi-tier architecture, UX design, data communication, cryptography, data science, smart contracts, transaction management, distributed network engineering, data security, data analytics, data modeling, mathematics and statistics.

Many stakeholders made reference to 'knowledge of any programming language plays a vital role'. For example, 'the knowledge of C#, Java would help in the development of blockchain-based solutions'. For developers, the importance of 'how to write on the blockchain from the frontend' was highlighted. Other stakeholders discussed the importance of 'domain-skills put into the context of Blockchain/DLT key concepts such as distributed consent, tokens, and smart contracts' and '[h]orizontal skills allowing to link different technologies (BC, AI, etc.)' combined with an 'awareness of the importance of trust and authenticity'. For example, domain expertise in legal, finance, medical, energy, etc. A smaller number of interviewees mentioned the importance to 'understand wallet and transaction time' for UX designer roles.

In relation to business skills, the most commonly discussed included ability and knowledge in the areas of: legal and compliance matters, finance and economics, product development, project management and implementation, business development, GDPR, sales and consulting, business model innovation, process development, service design, value orientation (to create user benefit), customer orientation, leadership, business organisation and composing technical documentation. Interviewees discussed the importance of an '[o]verarching understanding of technological, legal and commercial aspects'. For example, in terms of leadership, '[p]eople with pure technological view are sometimes disappointed by

Deliverable 2.3.1 – Blockchain Skill Demand

legal and commercial constraints, therefore empathy with other departments is important'. Other interviewees mentioned the importance of 'previous experience in proof of authenticity, origin, trust'.

In relation to transversal skills, the most discussed terms included capabilities in the areas of: cooperation competence, emotional and social intelligence, problem solving, creativity, system and network thinking, future-oriented mindset, remote work, languages (particularly English), teamwork, passion for new technologies, an appetite for continuous professional development, self-reliance, self-motivation, self-organisation, responsibility-taking, adaptability, project delivery, patience and strong communication skills (those who can understand and explain the blockchain technology). It was often suggested that 'there is a lack of communication skills to translate technical knowledge into business language'.

Many stakeholders made reference to skills in the area of business model innovation and the ability to 'think beyond the classical company models and roles' and 'process-oriented thinking'. Others suggested the importance of a 'diverse range of skills', 'agile-thinking', 'solution oriented', 'mindset for sharing', 'distributed collaboration, distributed trust, democratization', and 'following up fast with technological progress'. Some emphasized the need for 'ability to read documentation and experiment with technology that they might not totally understand initially'.

In sum, there is a 'need for a variety of roles and therefore skills in the industry'. More specifically, 'how to combine consulting with the business and technological parts'. While the important basic skills appear to be 'experience in programming skills, web development, and an eagerness to learn'. In terms of future progress, there was an understanding that 'increasing specialization will be required due to technological progress' in 'larger and more diverse application areas'.

Deliverable 2.3.1 – Blockchain Skill Demand

3.3.5 Summary of Findings

Job Adverts

- The most popular technical competencies requested by blockchain employers are "coding", "engineering", "frontend", "backend" and "design".

- The most popular business skills requested by employers are "management", "marketing", "finance", "product development", "design".

- The most popular transversal skills requested by employers are "self-competence", "co-operation", "responsibility", "product teamwork", "communication".

- 83% of adverts contained at least one of these technical skills, 56% of adverts contained at and 80% of adverts contained at least one of the listed transversal competencies.

- 42% of adverts contained at least one of the each of the listed technical, business and transversal competencies.

Online Survey

- 71% of responding firms reported that blockchain skills were either very important or somewhat important.

- 90% of responding firms consider transversal skills somewhat or very important.

- Over 90% of respondents also confirmed that transversal skills would be important for blockchain professionals within the next three years.

- Just over half of responding firms (155, or 51%) reported experiencing recruitment difficulties.

- Technical and blockchain specific skills were found to be of particular importance in the industry. Blockchain solutions design was particularly important for blockchain architects, coding skills for developers and while this skill set wasn't quite as important for Blockchain managers Blockchain solutions design and data analysis were deemed relatively important.

- Business skills not surprisingly were found to be particularly important for Blockchain managers, especially business needs analysis. For Blockchain architects, skills for blockchain use cases development were seen as particularly important while marketing skills were important for developers.

- Transversal skills were deemed to be important regardless of job type. In particular cooperation competence (team-working ability & emotional/social intelligence) was seen as important for all three typed of job roles i.e., blockchain managers, developers and architects.

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- In terms of the skills found to be missing/lacking in the industry, blockchain solutions design was found to be the most lacking amongst Blockchain architects (likewise for managers) and cryptography development was lacking amongst developers. On the other hand, nearly a half of firms found frontend and backend development skills not to be lacking (compared to the other skills) in the industry.

- In terms of business skills there is less variation across the job types than is the case in other areas. Business needs analysis, skills for Blockchain Use Cases development and skills in legal & compliance matters are all deemed to be missing/lacking within the industry regardless of role. Affiliate marketing skills and finance skills are not deemed to be missing/lacking to the same extent as other business skills.

- Overall, transversal skills are also not as often found to be missing/lacking compared to technical or business skillsets. In relative terms, however, decision competence is the most lacked skill for Blockchain architects, communication competence for developers and ethical & environmental competence for managers. Transversal skills are found not to be lacking in large numbers particularly amongst managers.

In-depth Interviews

- Many of the issues raised in the in-depth interviews related to the shortages of blockchain-related skills and candidates for positions. Some stakeholders highlighted that for instance 'developers and UX designers are already rare, and, as blockchain is a specialization, it makes [the Blockchain] employee rarer'.

- In terms of specific skills, stakeholders commonly discussed skills including knowledge of: Blockchain platforms, IT, algorithms, programming languages (Python, solidity language, C, C++, Java, etc.), software development, software architecture design, frontend/backend development, P2P network and multi-tier architecture, UX design, data communication, cryptography, data science, smart contracts, transaction management, distributed network engineering, data security, data analytics, data modelling, mathematics and statistics.

- In relation to business skills, stakeholders most commonly discussed abilities and knowledge in the areas of: legal and compliance matters, finance and economics, product development, project management and implementation, business development, GDPR, sales and consulting, business model innovation, process development, service design, value orientation (to create user benefit), customer orientation, leadership, business organisation and composing technical documentation.

- In relation to transversal skills, the most discussed terms discussed included capabilities in the areas of: cooperation competence, emotional and social intelligence, problem solving, creativity,

Deliverable 2.3.1 – Blockchain Skill Demand

system and network thinking, future-oriented mindset, remote work, languages (particularly English), teamwork, passion for new technologies, an appetite for continuous professional development, self-reliance, self-motivation, self-organisation, responsibility-taking, adaptability, project delivery, patience and strong communication skills (those who can understand and explain the blockchain technology). It was often suggested that 'there is a lack of communication skills to translate technical knowledge into business language'.

- In sum, there is a 'need for a variety of roles and therefore skills in the industry'. More specifically, 'how to combine consulting with the business and technological parts'. While the important basic skills appear to be 'experience in programming skills, web development, and an eagerness to learn'. In terms of future progress, there was an understanding that 'increasing specialization will be required due to technological progress' in 'larger and more diverse application areas'.

Deliverable 2.3.1 – Blockchain Skill Demand

3.4 Education and skill development support

In this section we assess current and future human capital requirements of blockchain employers.

3.4.1 Literature

LinkedIn currently offer courses to enhance knowledge of how Blockchain works and what the key development skills are for beginning a new career development path. The skills taught cover: knowledge on encrypted data storage, ability to build Blockchain decentralised apps, blockchain-based contracts and Blockchain programming, cryptocurrency foundations and security requirements for cryptocurrency (Linkedin, 2019).

Other short online courses are available but these are limited. It is likely given the newness of the technology, the ever-changing nature of technology and the complexity of blockchain that current experts in the field evolved from more standard computer technology positions and self-educated in blockchain as it emerged.

3.4.2 Evidence from the online survey

The education sector has an important role to play in ensuring that blockchain organisations are provided with well-qualified graduates that are equipped with the necessary skills for blockchain occupations. Responding firms were asked, "Which educational courses are most needed to better support the talent you seek to attract within your country?". The responses are shown below in Figure 15. Technical related courses were the most frequent answer (128 firms, or 42%). More specific courses, including "industry-specific use cases" and "solution architecture" are indicated by 54 (18%) and 48 (16%) firms, respectively. However, 39 firms (13%) indicate more general education courses based on transversal skill development.

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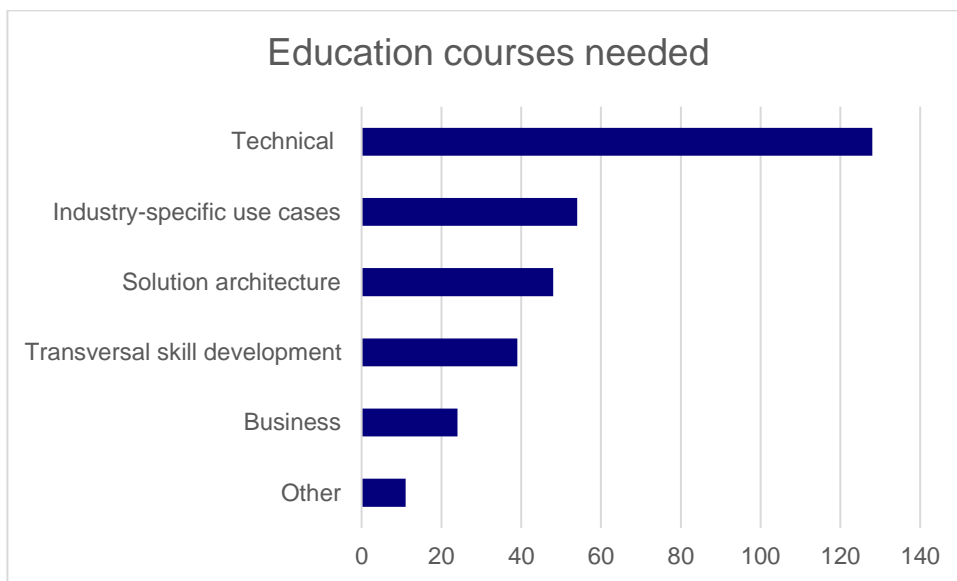
Figure 15 - Education level that organisations need to attract

As blockchain is a relatively new technology, there may be a lag in terms of formal or dedicated educational provision. As such, firms responding to the survey were asked, "From your point of view, will formal training and certification for the development of blockchain skills play a more or less important role in the future?". From Figure 16 below, we can see that the vast majority of firms (80%, or 242 firms) believe that it will play a more, or somewhat more, important role in the future.
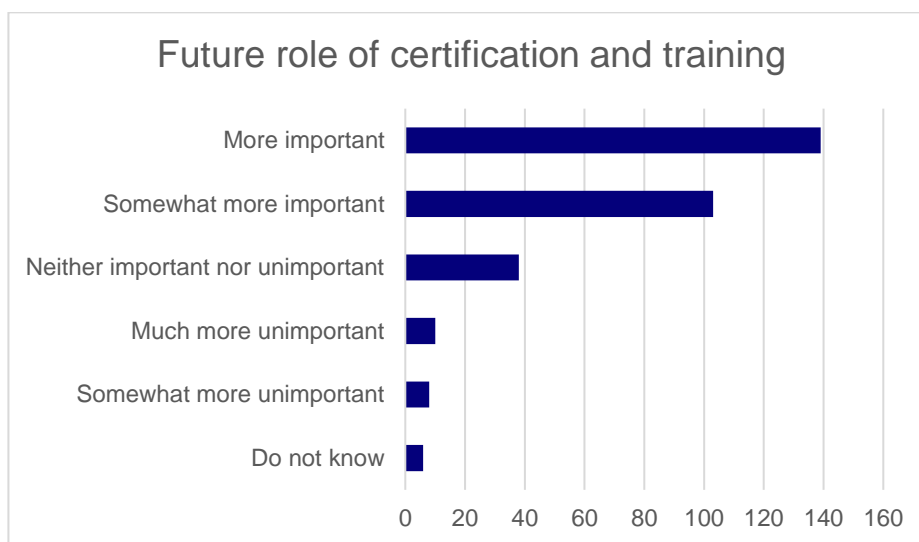
Figure 16 - How important organisations rate the future role of formal Blockchain skills certification and training

Deliverable 2.3.1 – Blockchain Skill Demand

3.4.3 Evidence from the job adverts

The relevant data relating to education and skills development supports available from the online job adverts is discussed above in Section 3.2.3.

3.4.4 Perceptions from in-depth interviews

A key focus of the in-depth interviews was to gather opinions on what stakeholders would like to see changed within the current education system and skill development supports. Much of the focus of the discussion around education in the area of blockchain centred around the perception that specific training and education programmes are lacking. However, it was also felt that '[s]pecialised training are becoming more available' and there are 'a few programmes upcoming'. It was also expressed that 'missing qualification programmes and missing governmental strategy has led to a skills gap'.

In terms of traditional educational routes, the average education level was generally discussed as 'an academic degree or certificate often in computer science or informatics'. However, this requirement was ideally combined with 'programming skills', 'knowledge of how blockchain works' and 'no specific experience requirement'. Some suggested that 'traditional education is not important but requires some training or knowledge of blockchain skills and basic programming skills' and argued that 'students can learn from various e-learning platforms like Udemy, Coursera etc'. In contrast, it was sometimes suggested that 'online courses today are too generic' and courses were required to include 'advanced knowledge for Blockchain architects and developers' and 'different courses for management on how to develop Blockchain business cases'. For example, the creation of 'interactive hands-on course structures not only for IT specialists but also people with a passion for Blockchain'. Furthermore, there was an emphasis on 'physical training sessions which could be conducted in-house or by private organisations'. Other exceptions from the university approach discussed were 'online tools and vocational training institutes are providing skills sets related to blockchain'.

Other stakeholders were very specific in what type of education programmes would be helpful, stating that 'in-person lectures should be divided into chunks of specific tasks every week' combined with 'industrial experience related tasks working on some actual project' or 'working in an organisation to on actual issues/software'. Many agreed that education pedagogies should be 'as interactive as possible and discuss topics with real world business cases'. Another example outlined that given the 'main criteria to enhance the skills of development/programming', the 'overall structure should be modular' and 'focus

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on backend and frontend technology for building blockchain-based applications'. Some emphasised how a key aspect of education provision was about 'developing entrepreneurial skills' as 'the big players are very entrepreneurial'. Furthermore, it was highlighted by a number of interviewees that 'around the coder, you need the whole spectrum of people, including marketing, PR, HR, and people who can talk to investors'.

One stakeholder suggested that there are 'two different situations: application developers or core developers'. More specifically, 'for application/adoption teams' the key skills required are: 'an in-depth comprehension of what is blockchain; juridic impact related to data manipulation; impact for regulated entities; competences in economy/finance, understanding the law, stay informed and being curious'. Alternatively, for the 'core developers teams' the following are required technical competences: 'code checking; Protocol Shell; Michelson (contract interpreter); OCaml; consensus layer; cryptography; Sapling protocol (privacy); zero knowledge proof (ZKp); code base verification; formal contract checking; and Coq'.

In discussions around the developments of in-house training for new employees many approaches were discussed as beneficial including: 'to provide resources and time for learning'; 'using blockchain specific books'; 'online tools and resources'; 'e-learning'; 'YouTube'; 'private organisations'; 'small group conversations'; 'sharing findings and what we have learned'; 'experienced employees providing training to new employees'; 'having mentors'; 'meetups with local Blockchain developers', 'get employees to attend conferences'; 'plan blockchain applications'; 'bring in advisors as needed'; 'support employees taking classes'; and 'being part of pilot proof of concept'. More specifically, one stakeholder suggested that the most appropriate in-house model consists of a following sequence of events: 'Do a one-week-long hackathon with a team on blockchain project; debate at the end how blockchain affected the decisions; involve as many fields as possible (business, dev, ux, ...), and repeat'.

Others argued that 'only in very specific cases are do companies usually invest in in-house training due to the high cost and lack of time'. Consequently, when a project requires the involvement of a large group of experts and the skills will be required over a long period of time, firms may decide to invest usually 'by providing training supported via the financing of online training session/MOOCs/online resources/seminars' and often 'any training offered...take[s] place outside office hours'.

Other stakeholders, however, differed from these views and felt that the blockchain employee 'needs to be very heavy internally driven', necessitating the drive to 'go online, go through all the white papers, start working with the systems, root level, bottom-up approach'. Some stakeholders argued that the relative emphasis on in-house training i.e. 'exploring the technology hands on and on-the-job training' was of most importance and agreed that 'no level of education or qualifications are needed'. It was also

Deliverable 2.3.1 – Blockchain Skill Demand

suggested that 'loyalty is super important' from new employees and 'a company will invest a lot for someone to become an expert as competition is strong'. Other interviewee's suggested that it is vital for companies and training providers to 'show new employees the training path', to nurture a 'mindset to let people evolve outside of their field', and to provide information on 'where to look for answers for questions' and 'who the key players are in order for new employees to follow their projects'. One stakeholder suggested that 'ideally, he would like new employees to have three-years experience but with enough interest, it is possible to learn the necessary skills in six months'.

In sum, the lack of appropriate training offerings in the Blockchain field is certainly one of the main issues faced by the sector. It is not difficult to find basic education and training courses on Blockchain providing general knowledge in this subject and, at the same time, many trainings already exist for any programming language, however, they are not viewed a highly appropriate. Those interviewed predominantly expressed that there continued to be a lack of 'appropriate' education and training available which included the necessary complex mix of skills required for different aspects of current and future Blockchain employment.

For technical specialists, a difference is required between solutions architects and developers. It was felt that architects need quite an extensive knowledge regarding what blockchain is, what blockchain can do, and how it can be integrated in already existing IT infrastructures etc. However, it is easier for developers to be operational quite quickly, even if they never worked on blockchain project before. They mostly need to adapt the skills that they already have (for example, coding in Java etc.) rather than learning a completely new skillset. When it comes to software development, in general 'agility, scrum and self-managed teams are the standard methodologies' and it is 'no surprise to see this applied to blockchain based solutions as well'.

Another significant issue seems to appear when 'an organisation requires more in-depth training to help its developers to make the transition in order to be able to use those programming languages in the context of the development of a blockchain-based solution'. Others also acknowledged the potential for 'domain experts with the ability of transferring the potential of Blockchain to their domains'. And the importance of 'know[ing] your job before specialising into Blockchain.' There were also several observations regarding the perception that there is 'a real need to train business specialists and managers'. In terms of future developments, it was suggested that '[i]t would be interesting to have a complete blockchain course available that captures the complete scope of project implementation, not only the technical part'. Most importantly, company managers want employees to 'to gain a broad knowledge and…to stay closely updated on field advancements'.

Deliverable 2.3.1 – Blockchain Skill Demand

3.4.5. Summary of Findings

- When asked which courses were demanded to better support talent, technical courses were supported by 42% of respondents.

- There was also a high demand for more specific courses in the areas of "industry-specific use cases" and "solution architecture".

- There was lower demand for courses on transversal and business skills.

- 80% of survey respondents felt that formal certification and training it will play an important role in future blockchain skills development.

- Those interviewed predominantly expressed that there continued to be a lack of 'appropriate' education and training available which included the necessary complex mix of skills required for different aspects of current and future Blockchain employment.

- In terms of traditional educational routes, the average education level was generally discussed as 'an academic degree or certificate often in computer science or informatics'. However, this requirement was ideally combined with 'programming skills', 'knowledge of how blockchain works' and 'no specific experience requirement'.

- Some suggested that 'traditional education is not important but requires some training or knowledge of blockchain skills and basic programming skills' and argued that 'students can learn from various e-learning platforms like Udemy, Coursera etc'.

- There was an emphasis on 'physical training sessions which could be conducted in-house or by private organisations'. Other exceptions from the university approach discussed were 'online tools and vocational training institutes are providing skills sets related to blockchain'. Many agreed that education pedagogies should be 'as interactive as possible and discuss topics with real world business cases'.

- For technical specialists, a difference is required between solutions architects and developers. It was felt that architects need quite an extensive knowledge regarding what blockchain is, what blockchain can do, and how it can be integrated in already existing IT infrastructures etc. However, it is easier for developers to be operational quite quickly, even if they never worked on blockchain project before. They mostly need to adapt the skills that they already have (for example, coding in Java etc.) rather than learning a completely new skillset.

- When it comes to software development, in general 'agility, scrum and self-managed teams are the standard methodologies' and it is 'no surprise to see this applied to blockchain based solutions as well'.

- It was highlighted by a number of interviewees that 'around the coder, you need the whole spectrum of people, including marketing, PR, HR, and people who can talk to investors'.

Deliverable 2.3.1 – Blockchain Skill Demand

- Some emphasised how a key aspect of education provision was about 'developing entrepreneurial skills' as 'the big players are very entrepreneurial'.

3.5 Perceived changes within Blockchain organisations

In this section we summarise perceptions regarding the likely direction of future change in the blockchain area.

3.5.1 Literature

A study by Deloitte (2020) found that 83% of senior executives felt their firm would lose a competitive edge if they did not adopt blockchain. Also, a very high proportion (88%) perceived Blockchain to be highly scalable and to eventually become mainstream. Others believe its growth will continue and it will become more widely used, although the complexity of the technology may inhibit this. Nearly 9 in 10 senior executives stated that digital assets would be somewhat or very important for their business over the next 3 years. Interestingly, 83% believe digital assets would serve as an alternative, or an outright replacement, of fiat currency in 5 to 10 years.

3.5.2 Evidence from the online survey

Blockchain is a relatively new technology that is being utilised within organisations. It is possible that the importance of blockchain technology, and the corresponding demand for blockchain skills within organisations, will increase in the coming years. The online survey asks firms, "How do you estimate the importance of blockchain for your organisation within the next 5 years?". The responses are shown in Figure 17 below. The vast majority (279 firms, or 92%) indicated that they expect blockchain to be either very important or somewhat important in the next five years. Firms were also asked how important blockchain is within their organisation today, and we saw these results earlier. Of the 35 firms that reported blockchain skills were either somewhat or not at all important today, 20 firms (57%) reported that they estimate blockchain skills will either be very or somewhat important in the next five years. This indicates that, even among firms where blockchain is currently not very important, there is a sense that blockchain will play a larger role in coming years.

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Blockchain importance - next 5 years
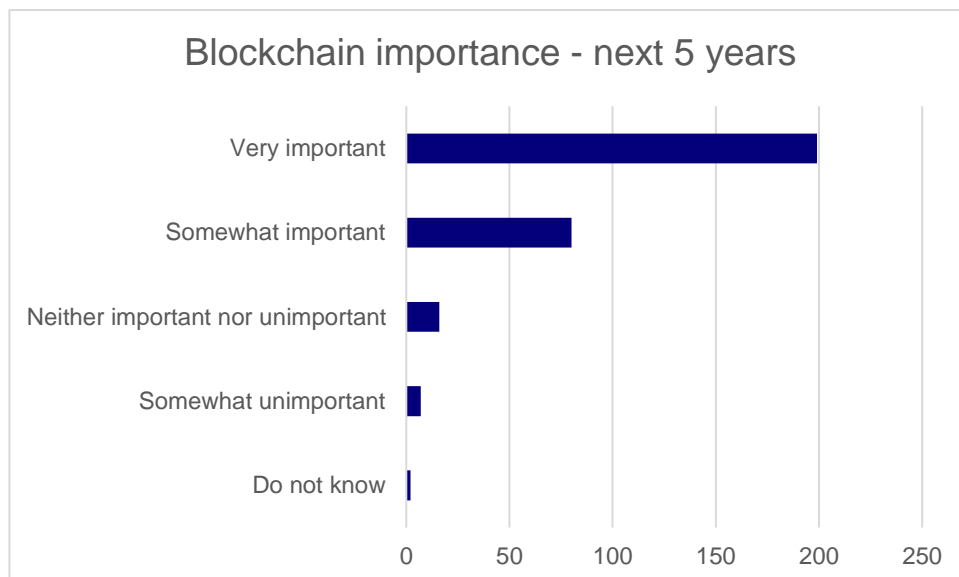
Figure 17 - How organisations rate the importance of Blockchain for them over the next 5 years

Having seen that many responding firms expect blockchain to be an important part of their organisation in coming years, we turn to a related question from the online survey that asks firms, "How do you think the size of your organisation's blockchain-related workforce will tend to change over the next 24 months?" Figure 18 shows that just over half (154 firms, or 51%) of all responding firms indicated that they expect the size of their blockchain workforce to slightly increase, while 30% (90 firms) indicated they expected a significant increase. Of the remaining firms, 14% thought their blockchain workforce would stay the same, 5% did not know, while just 1% expected a slight decrease.

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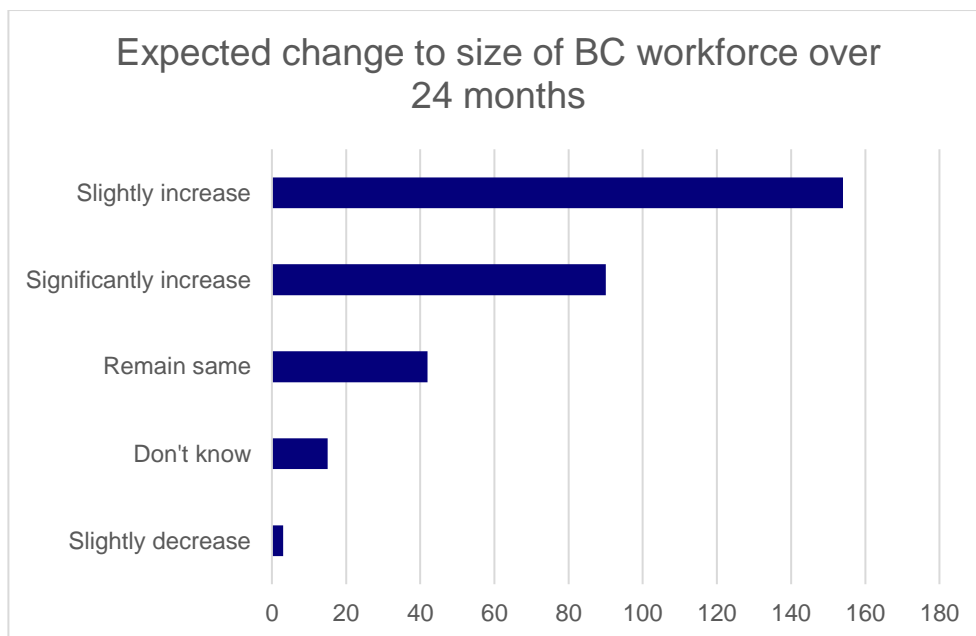
Figure 18 - Organisations expected change to the size of their Blockchain workforce within the next 2 years

3.5.3 Perceptions from in-depth interviews

Overall, there was an agreement that in the next five to ten years, there will be a higher need for 'specialisations (protocols, contracts, micro-services, etc.) on a technical level' and 'non-technical skills such as entrepreneurial skills, HR, social media, investment attraction'. These changes will necessitate 'increased employment in the sector' and 'more cooperation between organisations for implementing decentralized, distributed business models'. Some suggested that in future there would be less of a 'specific focus on Blockchain but also other decentralized approaches' leading to 'decentralized system teams'. Other stakeholders outlined that 'the current trends will surely be affected by the overall growth and development of the blockchain sector and its practical implementation/integration in multiple sectors of the economy'.

However, quite a few barriers were also identified by respondents when approaching developments in blockchain, including 'the legal aspects', 'the complexity of explanations' and 'hesitancy to approach new technologies'. Many interviewees reported that '[t]he potential has not yet been understood, because of confusion and the market hype'. One stakeholder described their favourite way to explain Blockchain as 'a decentralized network of computers, where each computer serves as evidence for a

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transaction, e.g. if I gave you €10 either of us could dispute that you ever received it, but if there is a witness, one can reach consensus, that the transaction took place'. Blockchain technology is perceived to 'evolve quickly' and 'Blockchain should come as a solution, not the goal'. It was suggested that 'companies need to repeatedly ask themselves if blockchain can solve their problem'.

The majority of respondents described the need 'for current decision makers to understand the value of blockchain for their business fields' and that 'missing qualification programmes and missing governmental strategy has led to the skills gap'. For example, 'combining blockchain/DLT with other enabling, disruptive technologies can increase trust in products through verifiability and traceability…and will also have a transformational impact on society and people's buying behaviour'.

Further developments for more appropriate training offerings in the Blockchain field was certainly suggested as one of the necessary changes within Blockchain organisations (as discussed in previous sections). However, some suggested that 'training the younger generation is a much faster process, since they enter the labour market with more developed and up-to date skills'. Furthermore, for future developments within the sector, it was emphasized that 'the ability to adapt and develop new skills at a fast rate is of vital importance, especially in fast-developing technologies such as blockchain' and that 'most blockchain projects do not fail for technical reasons but because of the governance'. With regard to long-term developments, it was projected that changes may include 'a significant increase in provision of in-house training as more and more employees will be working on blockchain related projects'.

In sum, stakeholders varied in their views on the most important perceived changes within Blockchain organisations into the future, with a selection of views particularly apparent relating to how the sector will expand, education and training provision, and overcoming other key barriers faced in the sector (for example, legal aspects, government regulation, complexity of explanations and hesitancy related to new technologies). However, there was an overarching consensus on 'constant evolution' and 'high-growth' within the field of Blockchain.

Deliverable 2.3.1 – Blockchain Skill Demand

3.5.4. Summary of Findings

- 92% of respondents to the survey indicated that they expect blockchain to be either very important or somewhat important in the next five years.

- Even among firms where blockchain is currently not very important, there is a sense that blockchain will play a larger role in coming years.

- 51% of all responding firms indicated that they expect the size of their blockchain workforce to slightly increase over the next 24 months, while 30% indicated they expected a significant increase.

- Stakeholders varied in their views on the most important perceived changes within Blockchain organisations into the future, with a selection of views particularly apparent relating to how the sector will expand, education and training provision, and overcoming other key barriers faced in the sector (for example, legal aspects, government regulation, complexity of explanations and hesitancy related to new technologies). However, there was an overarching consensus on 'constant evolution' and 'high-growth' within the field of Blockchain.

- There was an agreement that in the next five to ten years, there will be a higher need for 'specialisations (protocols, contracts, micro-services, etc.) on a technical level' and 'non-technical skills such as entrepreneurial skills, HR, social media, investment attraction'. These changes will necessitate 'increased employment in the sector' and 'more cooperation between organisations for implementing decentralized, distributed business models'.

4.0 Summary and Conclusions

Deliverable 2.3.1 – Blockchain Skill Demand

4.1   Conclusions

This study provides unique insights in the demand for blockchain skills within the EU. The research begins by providing some much-needed detail on both the structure and form of blockchain demand. Results from the online survey and in-depth interviews revealed that the most blockchain intensive industries are ICT, financial services and education. In terms of the firms that recruit blockchain talent, evidence from online job adverts indicated that almost three-quarters of recruiters were blockchain service providers. With respect to occupational profile, recruitment appears to be most concentrated within developer and engineering roles. Finally, using the distribution of blockchain job adverts as an indication of the geographical spread of demand, just 4 countries (Belgium, Germany, France and Italy) account for over 50% of all blockchain job adverts in this sample.

The report then profiled the characteristics of blockchain employees and found that less than two-thirds of firms reported that under 20% of women in their organisation work in blockchain. Nevertheless, this finding does not prove female under-representation in the sector and more work is required. Employees in the blockchain sector are typically young, with an average age of under 35, with possession of a post-graduate qualification also typical. Nevertheless, there is evidence from the online job advertisement data and in-depth interviews that employers do not tend to focus entirely on academic qualifications when hiring blockchain professionals. Over 40% of job adverts did not specify a minimum educational requirement or, alternatively, stated that no formal degree was required. This suggests that currently for a large proportion of blockchain employers, the possession of specific professional skills and/or labour market experience is of much higher importance than academic credentials. Over a third of new jobs appear to be open to new, or inexperienced, labour market entrants with either no, or up to 3 years' experience; rising to 52% when we also consider the proportion of job adverts with no stated experience requirements.

We sought to identify the skills currently being demanded by blockchain employers. Evidence from the online survey indicated a relatively high importance of both technical and transversal skills among blockchain workers. There was also a view that transversal skills will become increasingly important in the sector as time goes on. This view was also supported by the analysis of the job advert data and in-depth interviews which indicated that employers routinely sought technical competencies combined with transversal skills and business acumen.

The most popular technical competencies in blockchain job adverts are "coding", "engineering", "frontend", "backend" and "design". The most popular business skills in blockchain job adverts are

Deliverable 2.3.1 – Blockchain Skill Demand

"management", "marketing", "finance", "product development", and "design". The most popular transversal skills in blockchain job adverts are "self-competence", and "co-operation", "responsibility", "product teamwork", and "communication". We found that 42% of job adverts contained at least one of the most commonly requested technical, business and transversal competencies. Finally, there is some evidence of potential skill shortages in the sector with just over half of firms surveyed reporting having experienced recruitment difficulties.

Those interviewed suggested that there is a 'need for a variety of roles and therefore skills in the industry'. More specifically, 'how to combine consulting with the business and technological parts'. While the important basic skills appear to be 'experience in programming skills, web development, and an eagerness to learn'. In terms of future progress, there was an understanding that 'increasing specialization will be required due to technological progress' in 'larger and more diverse application areas'.

Finally, stakeholders interviewed varied in their views on the most important perceived changes within Blockchain organisations into the future, with a selection of views particularly apparent relating to ways in which the sector will expand, education and training provision, and overcoming other key barriers faced in the sector (for example, legal aspects, government regulation, complexity of explanations and hesitancy related to new technologies). However, there was an overarching consensus on 'constant evolution' and 'high-growth' potential within the field of Blockchain.

4.2   Implications for Policy

The results from the study point to the fact that the blockchain sector is still in the relatively early stages of development. The evidence from the job vacancy data and the response rate from the employer survey suggests that the demand for blockchain workers is yet somewhat unevenly spread across EU countries. Furthermore, there is no clearly defined occupation and industry associated with blockchain employment, which makes it very difficult to measure the evolution of labour demand. Instead, what we have found is that blockchain workers are located in sectors such as ICT, Financial Services, Education, Research and the Public Sector. In terms of occupations, blockchain employees work as either Developers or Engineers, they are also found in occupations such as Consultants, Managers, Architects as well as a range of smaller occupations. In terms of recruitment, the evidence suggests that many employers place a relatively low weighting on formal qualifications and are instead more interested in staff possessing specific competencies and skills. Furthermore, there is no clear-cut competency set

Deliverable 2.3.1 – Blockchain Skill Demand

associated with blockchain demand, while many employers require some programming skills, these can be requested alongside a wide range of business and transversal skills that vary widely according to job type, occupation and sector.

The diverse nature of blockchain employment makes it extremely difficult to develop policies designed to ensure that the demand for labour is met and that employers are not faced with potentially costly skills mismatches. Skills mismatches can take numerous forms, however, those most relevant to employers are:

- Unfilled and hard-to-fill vacancies
- Skills gaps (under-skilling)
- Over-skilling

The consequences of skill mismatches on firm-level performance are highly debated and, while it is generally assumed that skills mismatches are harmful to productivity, the evidence for this assumption is somewhat limited. Nevertheless, Bennet & McGuinness (2009) report evidence that hard-to-fill and unfilled vacancies reduced per worker output levels by between 65% and 75% when they occurred among high-tech firms in Northern Ireland. Skill gaps refer to inadequate skills among the existing workforce and generally point to deficiencies both in the formal education sector and firm-level training. McGuinness & Ortez (2016), again using Irish data, found evidence that employer reported skill gaps lead to increases in both average labour costs and training costs. With regard to over-skilling, this refers to a situation where workers report being unable to utilise all of their skills and abilities within their current jobs, there exists a large amount of evidence that over-skilled workers earn a wage penalty and this again points towards lower worker/firm level productivity (see McGuinness, Pouliakas & Redmond 2018, for a review). The dispersed nature of the blockchain sector makes it very difficult to monitor, measure or predict various forms of skill mismatches and devise policies in order to mitigate their impacts.

Nevertheless, the employer survey carried out as part of the current study does allow us to at least get some sense on the extent of labour demand which we can then link to one form of skills mismatch i.e. hard-to-fill vacancies. Eurostat (2021) defines a job vacancy as a paid post that is newly created, unoccupied, or about to become vacant:

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- for which the employer is taking active steps and is prepared to take further steps to find a suitable candidate from outside the enterprise concerned; and

- which the employer intends to fill either immediately or within a specific period of time.

Using the information provided in the European Online Survey, the job vacancy rate (JVR) of total firm employment, is calculated as follows:

- JVR = number of blockchain job vacancies / (number of occupied posts + number of job vacancies) * 100

Furthermore, we also estimate the JVR as a percentage of the total firm BC employment:

- JVR = number of blockchain job vacancies / (number of blockchain occupied posts + number of blockchain job vacancies) * 100

For the Q1 2021 period, which aligns most closely to our survey data, average vacancy rates in the EU area stood at 2.1%. In the survey respondents were asked to record both total employment and blockchain employment, allowing us to estimate both a general and blockchain vacancy rates. From Table 25 it is clear that both the general and BC specific vacancy rates lie well above the EU average, at 12.51% the blockchain JVR is over 6 times the EU average, pointing to a very high level of relative labour demand for BC workers. Focusing on the different dimensions of BC employment, we can see that the BC JVR is above the EU average across almost all dimensions of employment, however, it is higher among BC providers relative to BC users (Table 26) and in sectors such as ICT, Financial Services and 'Other' (Table 27). The Blockchain JVR is also highest among smaller organizations (Table 28), however, this is to be expected as the denominator of the JVR calculation will be higher in larger firms which tends to generate a smaller JVR.

Job Vacancy Rates	Obs.	Mean	Std. Dev.	Min.	Max.
JVR of Total Employment	282	6.73	13.31	0	90.90
JVR of BC Employment	282	12.51	22.16	0	93.46

Table 25 - Estimated Job Vacancy Rates (JVR) from Online Survey

Primary Blockchain Purpose	Freq.	JVR Total Emp	JVR BC Emp
Primarily users of Blockchain/DLT	88	2.92	8.17

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Primarily providers of Blockchain / DLT Services	136	8.38	13.93
Both	58	8.64	15.75
Total	282	6.73	12.51

<div align="center">Table 26 – Job Vacancy Rate (JVR) by Primary Blockchain Purpose from Online Survey</div>

Sector	Freq.	JVR Total Emp	JVR BC Emp
Education	33	2.94	9.06
Financial Services	35	6.49	10.46
ICT	110	7.90	14.12
Public Services	9	0.71	2.17
Research	18	1.22	2.28
Other	77	8.80	16.22
Total	282	6.73	12.51

<div align="center">Table 27 – Job Vacancy Rate (JVR) by Sector from Online Survey</div>

Firm Size	Freq.	JVR Total Emp	JVR BC Emp
1-10	103	12.31	22.71
11-50	66	8.15	13.20
51-200	37	1.88	6.60
201-500	22	0.89	2.29
501-1000	10	0.17	0.82
1001-5000	20	0.55	0.48
5001-10000	9	0.02	0.08
>10000	15	0.02	0.21

<div align="center">Table 28: Job Vacancy Rates (JVR) by Firm Size from Online Survey</div>

It is clear that there is a high relative demand for BC workers at an EU level and, from our earlier survey analysis, we also know that 50% the firms in the sample reported some recruitment difficulties, which is suggestive of skill shortages. So how does the demand for labour and the experience of recruitment difficulties relate to each other? Is it the case that recruitment difficulties are highest among firms with

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the greatest JVR or is the incidence more widespread? To explore this, we run a basic probit model where the dependent variable is binary in nature and indicates that the firm reported a recruitment difficulty, the explanatory variables include the JVRs as well as controls for employer purpose and sector.

	(1)	(2)	(3)
VARIABLES	Recruitment Difficulties	Recruitment Difficulties	Recruitment Difficulties
JVR Rates:			
JVR	-0.00	0.01***	
	(0.005)	(0.004)	
BC JVR	0.01***		0.01***
	(0.003)		(0.002)
Primary Purpose: Base Case=Both			
BC User	-0.20**	-0.18**	-0.19**
	(0.088)	(0.087)	(0.088)
BC Provider	0.08	0.06	0.07
	(0.082)	(0.082)	(0.082)
Sector: Base Case=ICT			
Education	0.06	0.07	0.07
	(0.105)	(0.103)	(0.104)
Financial Services	0.17*	0.15	0.16
	(0.101)	(0.098)	(0.100)
Public Services	-0.05	-0.07	-0.05
	(0.163)	(0.166)	(0.164)
Research	-0.00	-0.02	-0.00
	(0.131)	(0.131)	(0.131)
Other	0.05	0.04	0.05
	(0.079)	(0.078)	(0.079)
Observations	282	282	282
Pseudo R2	0.111	0.085	0.110
Wald Chi2	40.35	26.13	38.01
Prob > Chi2	0.000	0.000	0.000

Table 29: The Determinants of Recruitment Difficulties

As the Total JVR and BC JVR are likely to be correlated, we estimate three models where we include each JVRs separately and then together. The results are presented in Table 29. It is clear that the there is a strong relationship between the JVR's and the incidence of recruitment difficulties, with the first model confirming the BC JVR is a more dominant predictor of a skill shortage than the general JVR.

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Model 1 indicates that for every one point increase in the BC JVR increases the probability of the firm reporting a recruitment problem by one percentage point.

Taken as a whole the research suggests that the demand for blockchain labour is very high relative to the EU average and that firms with high BC JVR's are much more likely to experience skill mismatches in the form of unfilled or hard-to-fill vacancies. There is a clear need to develop a strategy to address the issue going forward as the demand for labour accelerates. However as pointed out earlier, the means of achieving this is far from straightforward given the diverse nature of BC labour demand. Finally, it is worth noting from Table N5, that while sector is not a strong predictor of a recruitment difficulty, firms who are BC users are approximately 20 percentage points less likely to report a recruitment problem compared to firms who are (i) BC providers only or (ii) firms who are both BC providers and users.

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6.0 Appendices

Appendix A: Supplementary Tables from Job Adverts Data

	Top Technical	Top Business	Top Transversal
ICT	88.62	57.49	83.83
ICT & Other	76	72	92
Fin serv	81.82	47.73	75
Fin serv & other	50	50	75
Other	91.04	47.76	79.1

Table A 1 - Distribution of Adverts requesting commonly identified competencies by Industry (%)

	Top Technical	Top Business	Top Transversal
Linkedin	80.33	57.38	85.25
Indeed	86.21	65.52	79.31
Blockchain4talent	81.48	48.15	100
Eures	100	86.67	100
Eurojobs	100	86.67	100
Bamboo HR	100	57.14	100
Bitstamp	83.33	50	83.33
Other	88.89	48.72	78.63

Table A 2 - Distribution of Adverts requesting commonly identified competencies by Job Portal (%)

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	Top Technical	Top Business	Top Transversal
Austria	100	46.67	100
Belgium	79.25	60.04	92.45
Bulgaria	90	50	90
Denmark	100	100	100
Estonia	68.75	43.75	56.25
France	76.32	55.26	94.74
Germany	92.31	57.69	78.85
Greece	92.86	96.43	96.43
Ireland	100	84.62	100
Italy	97.37	50	57.89
Luxembourg	85.71	42.86	100
Netherlands	100	75	100
Poland	100	100	100
Portugal	100	100	100
Romania	100	53.33	100
Slovenia	60	28	60
Spain	100	100	91.67
Sweden	75	100	100

Table A 3 - Distribution of Adverts requesting commonly identified competencies by Country (%)

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	Top Technical	Top Business	Top Transversal
Developer	94.8	48	76.8
Engineer	94.12	55.88	86.76
Architect	94.12	76.47	82.35
Consultant	77.42	58.06	100
Analyst	75	37.5	87.5
Manager	50.09	59.09	86.36
Researcher	100	28.57	85.71
Growth hacker	60	80	100
Other	75.47	73.58	79.25

Table A 4 - Distribution of Adverts requesting commonly identified competencies by Job Role (%)

	Top Technical	Top Business	Top Transversal
Entry	86	57	86
Mid	88.52	60.66	83.61
Mid-senior	84.09	65.91	86.36
Senior	89.89	56.94	80.56
Not specified	82.14	42.86	78.57

Table A 5 - Distribution of Adverts requesting commonly identified competencies by Seniority level (%)

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Appendix B: Supplementary Figures for Skills Missing/Lacking from the Online Survey

Proportion who do not consider these technical skills to be missing/lacking

(Horizontal bar chart, x-axis "%", ranging from 0 to 60)

- Frontend & Backend Development
- Cloud and Infrastructure Design
- UX Design
- Scientific computing
- Coding (C++, Python, Java)
- Data/ Network Security Design
- Data Analysis
- Distributed network engineering skills
- Protocol engineering
- Maths and Stats
- Smart Contract Development
- Development of decentralised apps
- Cryptography development
- Blockchain Solutions Design

Figure B 1- Proportion of firms who do not consider particular Blockchain specific and technical skills to be missing/lacking

Proportion who do not consider these business skills to be missing/lacking

(Horizontal bar chart, x-axis "%", ranging from 0 to 50)

- Affiliate marketing
- Finance and Controlling skills
- Customer Success design
- Product Development skills
- Human Resources development skills
- Product Management skills
- Marketing skills
- Business Development skills
- Business (Needs) Analysis
- Skills in legal & compliance matters
- Skills for (Blockchain) Use Cases development

Figure B 2 - Proportion of firms who do not consider particular business skills to be missing/lacking

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Proportion who do not consider these transversal skills to be missing/lacking

Skill	
Systems & Networked thinking	
Initiative and performance competence	
Cooperation competence	
Self-determination & Autonomy	
Learning literacy & Metacognitive Skills	
Self-management/ organization/ regulation &…	
Sensemaking	
Ethical & Environmental competence	
Self-efficacy & Self-confidence	
Future mindset & willingness to change	
Design-thinking competence	
Innovation & Creativity skills	
Ambiguity competence	
Decision competence & Responsibility-taking	
Communication competence	

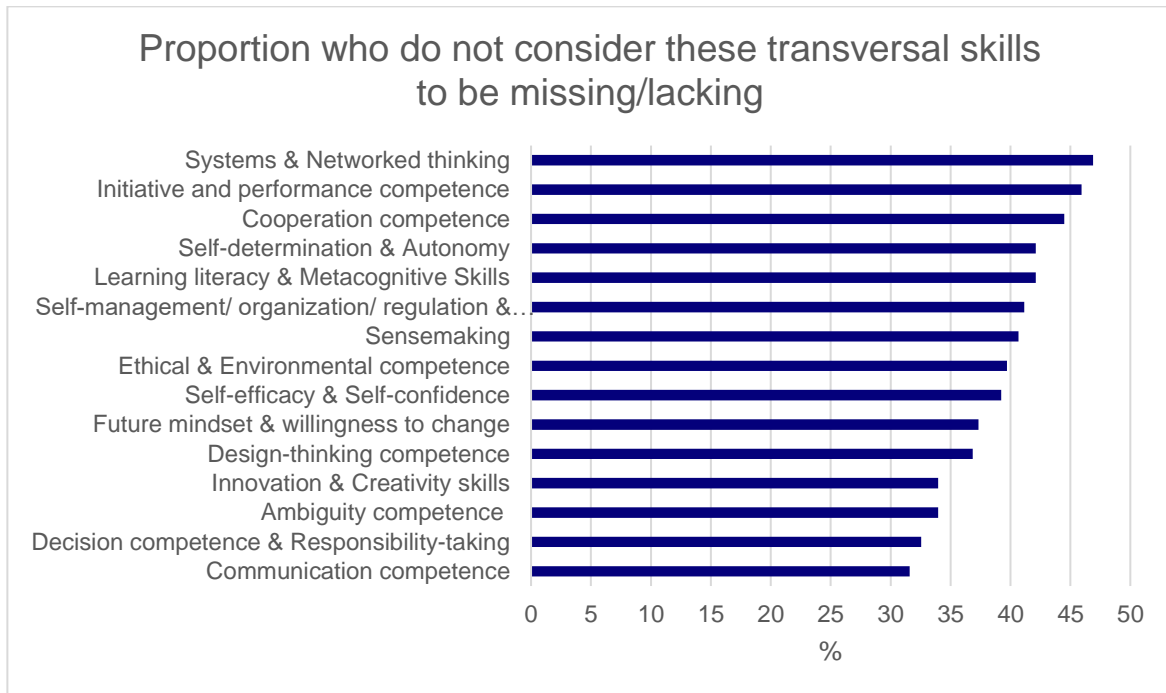% (x-axis: 0 5 10 15 20 25 30 35 40 45 50)

Figure B 3 - Proportion of firms who do not consider particular transversal skills to be missing/lacking

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