chaise

blockchain skills for Europe

D2.4.1:

Study on Blockchain skill supply

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DISCLAIMER

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

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Abbreviations

AF	Application Form
D	Deliverable
DG	Directorate General
EACEA	Education, Audiovisual and Culture Executive Agency
EQF	European Qualification Framework
EC	European Commission
EU	European Union
D	Deliverable
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 Methodology

This activity aims to identify the current level of Blockchain related skills and competences within the EU labour market (skill supply) by:

- Reviewing existing formal (Blockchain academic and VET courses) and non-formal (online courses, seminars and courses offered by ICT companies) Blockchain education and training provision in the consortium countries, and where possible in other EU countries (the rationale is that educational offerings can act as a proxy measure of skill supply in the labour market);
- Searching online ICT communities and to find out how ICT professionals choose to upskill themselves and follow the Blockchain career path;
- Interviewing E&T providers of Blockchain programs in Europe;
- Analysing statistical databases information on the field (e.g. programming, computer science) and level of education of Blockchain (EQF level) professionals, and participation in continuing VET;
- Running an online survey addressed to ICT companies delivering Blockchain services on the actual skills of the Blockchain workforce.

Table 1 – Factsheet

Fact Sheet	T2.4 Identification of existing skill supply
Task	T2.4 Identification of existing skill supply (M4- M7)
Objective	The study will identify technical and non-technical skills required in Blockchain related works
Related deliverables	D 2.4.1 Study on Blockchain skill supply D 2.4.2 Registry of Blockchain educational and training offerings
Research activities	1.In-depth expert interviews with E&T providers of Blockchain programs in Europe; 2.Review and analysis of existing formal and non-formal Blockchain education and training provision 3.Desktop research on online ICT communities and fora to find out how ICT professionals choose to upskill themselves and follow the Blockchain career path 4.Database analysis of information on the field (e.g. programming, computer science) and level of education of Blockchain (EQF level) professionals, and participation in continuing VET ((Please note: This task was conducted together with Task 2.2#1) 5.Field research - Online survey

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1.1 In-depth interviews

Objectives/aim: Gain evidence of skills supply from education and training providers
(Interviewing E&T providers of Blockchain programs in Europe)

Research Questions:

1. Blockchain Skill Development on a national level/ Policy Level: In your country

- Are specific qualification frameworks/ programs/ measures existing on a national or regional/ subregional level in EMS which are specifically aiming at supporting BC Skill development? (e.g. through associations, qualification agencies, professional associations, from state actors, policy makers, etc.)

deepening questions

- How is the institutional structure of skill provision related to BC skills organised on a national level? Who are the responsible actors to support BC relevant skill development? Can different strategies be identified and described?
- From a policy viewpoint: What are the needs for qualification within the field of BC relevant skills today and in the near future?

2. Blockchain Skill Development through Institutions & E&T Program (Providers): In your country

- Are specific formal qualification programs existing on an institutional level in EMS which are specifically aiming at supporting BC Skill development? (e.g. VET or academic Programs with specific explicit BC skill related focus, short courses with specific BC skill related focus, further & ongoing qualification offerings/ weekend courses/ online courses with a specific BC skill related focus)

Deepening questions

- Analysis of VET courses and programs: Which BC relevant skills are implicitly and explicitly currently embedded into the curricula of and provided through formal VET courses OR provided by ICT companies or other online courses or seminars?

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- How is the importance of BC relevant skill development reflected within the entire area of ICT relevant skill provision through seminars, online courses, VET programs and/ or academic programs?
- Is there a seamless provision of upskill-offerings within the formal education sector or are there structural barriers for IT professionals to become upskilled?

3. Now let's turn to teaching/ learning aspects…: From your experience

- What are successful/ appropriate ways/ concepts to teach BC relevant skills?
- Which role is formal training and teacher-cantered approaches vs. peer-learning approaches playing?
- How is the important role of future skills/ soft skills reflected within the education/ training programs?
- What BC skills level are you addressing? (Introductory, intermediate, advanced)

Deepening questions

- How do teachers/ trainers gain the necessary qualification to support learners in developing BC relevant skills? (Are BC teachers assuming a role of coaching rather than knowledge bearers?)
- Which role do official/ formal certifications play for BC relevant skill supply?
- Are there certificates for BC professionals? (Certificates, micro credentials, alternative credentials)
- Which are the usual formats for education and training offerings to support BC relevant skill development (online, offline/ asynchronous, synchronous, blended)?

4. Also: We are interested in the way organisations are internally organising E&T…

- What are successful strategies to organise qualification/ skilling/ upskilling/ reskilling of the workforce within the organisations? What are successful elements of the trainings? (e.g. videos, self-assessment tools, infographics, live online events, etc)
- Are there explicit BC relevant skill development programs existing?

5. It seems that for BC Skills informal learning plays a huge role - what is your opinion…?

- Is it possible to find, analyse and describe the online (and if: offline) tools, communities and fora which professionals use to further educate and upskill themselves to BC relevant skills

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Method (6-3 Interviews, approx. 45 minutes each):

Step-by-step Research Process:

- Minimum of 6 E&T providers consulted via interviews to gain in- depth information
- Interviews conducted by CIMEA, YPEPTH, UL will each interview 2-3 Education & Training providers.
- The E&T providers should be chosen on basis of the following criteria:
    - Experience with VET, Post-secondary VET or higher VET E&T Programs in the field of ICT, preferably relevant to Blockchain
    - Experience with Apprenticeships
    - Experience with short courses for ICT professionals helping them to upskills their Blockchain skills
    - Experience with providing work-based learning opportunities, guiding IT/ Blockchain professionals in upskilling processes
    - Experience in supporting personal and social learning processes
- Interviews will be recorded through audio files, ZOOM recordings
- All interview which are recorded will be transcribed and analysed according to the questions provided through the interview guideline, they will be paraphrased, doubles deleted and revised into clean English language text

Result: All the completed interview record forms will be forwarded to UL for analysis and integration into the final deliverable (D2.4.1: Study on BC skill supply).

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1.2 Analysis of existing formal & non formal Blockchain Education and Trainings

Objectives/aim: Gain evidence of skills supply of education and training provision through a review and analysis of existing formal and non-formal Blockchain education and training provision

Research Questions:

- Are specific formal qualification programs existing on an institutional level in EMS which are specifically aiming at supporting BC Skill development? (e.g. VET or academic Programs with specific explicit BC skill related focus, short courses with specific BC skill related focus, further & ongoing qualification offerings/ weekend courses/ online courses with a specific BC skill related focus)
- Analysis of 100 VET courses and programs: Which BC relevant skills are implicitly and explicitly currently embedded into the curricula of and provided through formal VET courses OR provided by ICT companies or other online courses or seminars? (The majority of the analysed programs should be EU programs)
- How is the importance of BC relevant skill development reflected within the entire area of ICT relevant skill provision through seminars, online courses, VET programs and/ or academic programs?
- Are there described/ official/ usual qualification pathways for IT professionals to become BC professionals?
- Is there a seamless provision of upskill-offerings within the formal education sector or are there structural barriers for IT professionals to become upskilled?
- Are there certificates for BC professionals? (Certificates, micro credentials, alternative credentials)
- Which are the usual formats for education and training offerings to support BC relevant skill development (online, offline/ asynchronous, synchronous)?
- Are there explicit BC relevant skill development programs from BC industry user organisations existing?

Method (desk research and quantitative content analyses)

Step-by-step Research Process:

- Desk research and quantitative content analyses of 100 current education and training (majority EU related) provision from
- existing formal (Blockchain academic and VET courses)
- non-formal (online courses, seminars and courses offered by ICT companies)

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- in the 13 consortium countries (France, Belgium, Greece, Austria, Germany, Spain, Italy, Luxembourg, Slovenia, Estonia, Romania, Bulgaria, Ireland), and where possible in other EU countries11; from 2018-2020.
- UCBL, UT, INDUSTRIA, ACQUIN, UPC, UL, CIMEA, DIGITALEUROPE will provide input regarding 12-14 Blockchain academic/training programs offered in their own countries and networks

Result: The final result will be the registry of BC educational and training offerings.

1.3 Desk research on online Blockchain communities and fora

Objectives/aim: Gain evidence on skills that are currently provided by BC ICT communities and fora and how ICT professionals choose to upskill themselves in order to follow the Blockchain career path.

Note: Searching online ICT communities and to find out how ICT professionals choose to upskill themselves and follow the Blockchain career path

Research Questions (individual level):

- Research, analyse and describe the online (and if: offline) tools, communities and fora which professionals use to further educate and upskill themselves to BC relevant skills?
- What are the individual online or offline strategies of IT professionals to upskill themselves to BC relevant skills?

Method (desk research and quantitative content analyses):

Step-by-step Research Process:

- analyse evidence from research papers on informal and peer-learning of ICT professionals,
- desk research to identify and categorize 15 online communities and fora, national context,
- thematic context,
- size (number of users),
- relation to Blockchain,
- identification of most relevant global BC/ ICT related online communities and for and
- analyse individual skilling strategies

Result: UL analysed evidence and draft the final Report on Blockchain skill supply.

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1.4 On-line survey

Objectives/aim: Online survey addressed to ICT companies delivering Blockchain services on the actual skills of the Blockchain workforce (running an online survey addressed to ICT companies delivering Blockchain services on the actual skills of the Blockchain workforce)

Research Questions:

- What are successful strategies to organise qualification/ skilling/ upskilling/ reskilling of the workforce within the organisations?
- Are there explicit BC relevant skill development programs existing?
- From the users' organisation perspective: What are the needs for BC relevant qualification now and in the near future?
- What is the level of skill supply?
- What are characteristics of underskilling (BC relevant skills needed?) overskilling (fields where BC relevant skill supply is over-demand) skills mismatch (BC relevant skill allocation does not work) in the Blockchain field?

Method:

Standardised quantitative online survey. Step-by-step Research Process (see T2.3#4)

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2 Quantitative analysis

Data for the Blockchain skill supply were obtained with:

- In-depth interviews
- Desk research
  - Analysis of existing formal & non formal BC E&T
  - Desk research on online BC ICT communities and fora
- Online survey

2.1 In-depth interviews

2.1.1 Providers of Blockchain knowledge

Total numbers of In-depth interviews of BC knowledge providers: 7

Country:

- Slovenia 3
- Italy: 2
- Greece: 2

Gender:

- Male: 6
- Female: 1

Providers by Legal Status:

- Private: 3
- Public: 4

Position at the institution:

- Expert: 3
- Manager: 2
- Researcher: 2

2.1.2 Companies

Total numbers of companies: 26

Number of employees: 2 – 380.000

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Country:

- Austria: 3
- Belgium: 4
- Estonia: 3
- France: 4
- Germany: 3
- Greece: 2
- Italy: 2
- Slovenia: 2
- USA: 3

Gender:

- Male: 6
- Female: 24

Position at the institution:

- Developer: 7
- Manager: 15
- Researcher: 3
- Other: 1

Industry:

- BC/DLT/AI strategies – consulting: 10
- Information technology/Software development: 4
- Aeronautic, Space and Defence: 1
- All (IBM): 1
- Research: 1
- Cinema: 1
- Education: 1
- Financial services: 1
- Gaming: 1
- Healthcare sector for medical processing: 1
- Logistics: 1
- Networking: 1
- Telecommunications: 1
- Transportation: 1

2.2 Desk research

2.2.1 Online communities and fora

Total number of Identified and analysed BC ICT communities and fora: 17

Total number of members: more than 7.7 MIO.

Location of communities/fora /members:

- Facebook 4 (577.800 members)
- LinkedIn 4 (2.681.840 members)
- Reddit Group 8 (4.470.600 member)
- Other 1 (no info about members)

List of BC ITC communities and fora:

1. Ethereum Community Forum, https://forum.ethereum.org/
2. Blockchain Developers, https://www.facebook.com/groups/bitcoin.developers
3. Developers - Android, iOS developer, Blockchain, Ethereum, https://www.linkedin.com/groups/54723/
4. #1 Global BITCOIN BlockChain, Ai, Digital, Tech (Network in over 18 countries), https://www.linkedin.com/groups/2256606/
5. Software & Technology Professionals: Managers | HR | Recruiters | Blockchain | Investors, https://www.linkedin.com/groups/1976445/
6. Big Data, Machine Learning, Data Science, Artificial Intelligence, IoT & Blockchain, https://www.linkedin.com/groups/3990648/
7. Cryptocurrency Technology Focused Discussions, https://www.reddit.com/r/CryptoTechnology/
8. Bitcoin - The Currency of the Internet, https://www.reddit.com/r/Bitcoin/
9. Sharing of ideas, tips, and strategies for increasing your Bitcoin trading profits, https://www.reddit.com/r/BitcoinMarkets/
10. Bitcoin & Blockchain Development and use, https://www.facebook.com/groups/developmentblockchain/?notif_id=1615474769639616&notif_t=group_r2j_approved&ref=notif
11. Captain Altcoin - Cryptocurrency Community, https://www.facebook.com/groups/cryptoland
12. Bitcoin - A Peer to Peer Electronic Cash System, https://www.reddit.com/r/btc/
13. Bitcoin mining invest, https://www.facebook.com/groups/1323870251076743

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14. Bitcoin News Uncensored, https://www.reddit.com/r/bitcoin_uncensored/
15. CryptoCurrencies, https://www.reddit.com/r/CryptoCurrencies/
16. Bitcoin for Beginners, https://www.reddit.com/r/BitcoinBeginners/
17. Ethereum, https://www.reddit.com/r/ethereum/

2.2.2 Blockchain educational and training offerings

Total Blockchain Courses: 120

Providers by Legal Status:

- Private: 87
- Public: 29
- Others: 4

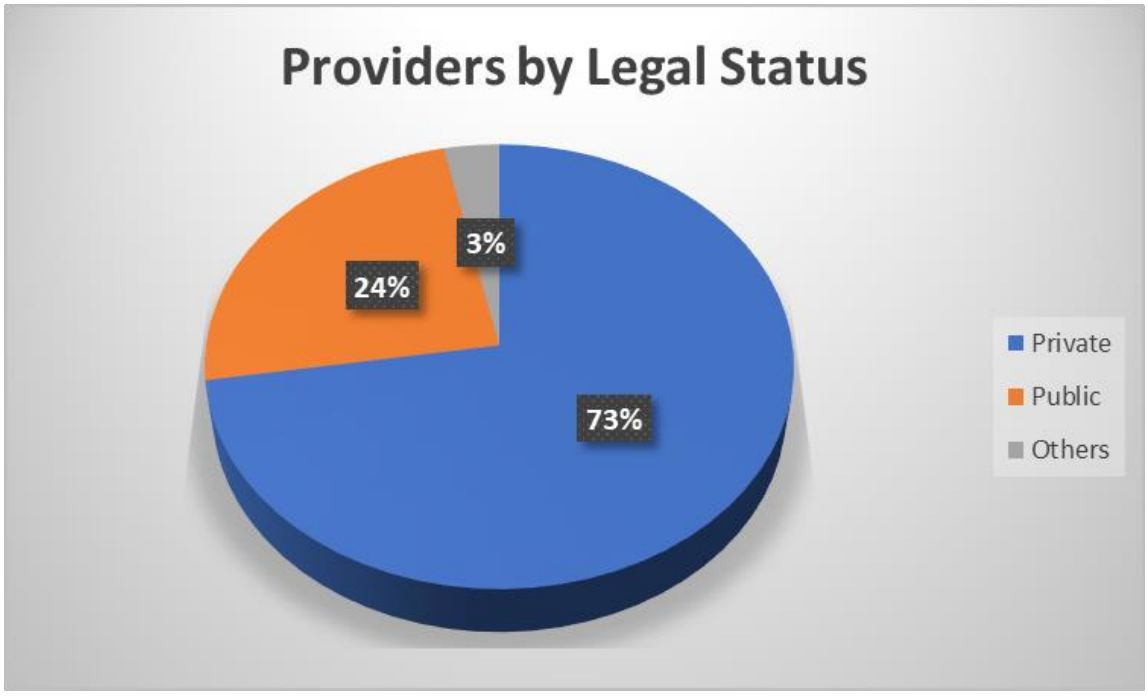


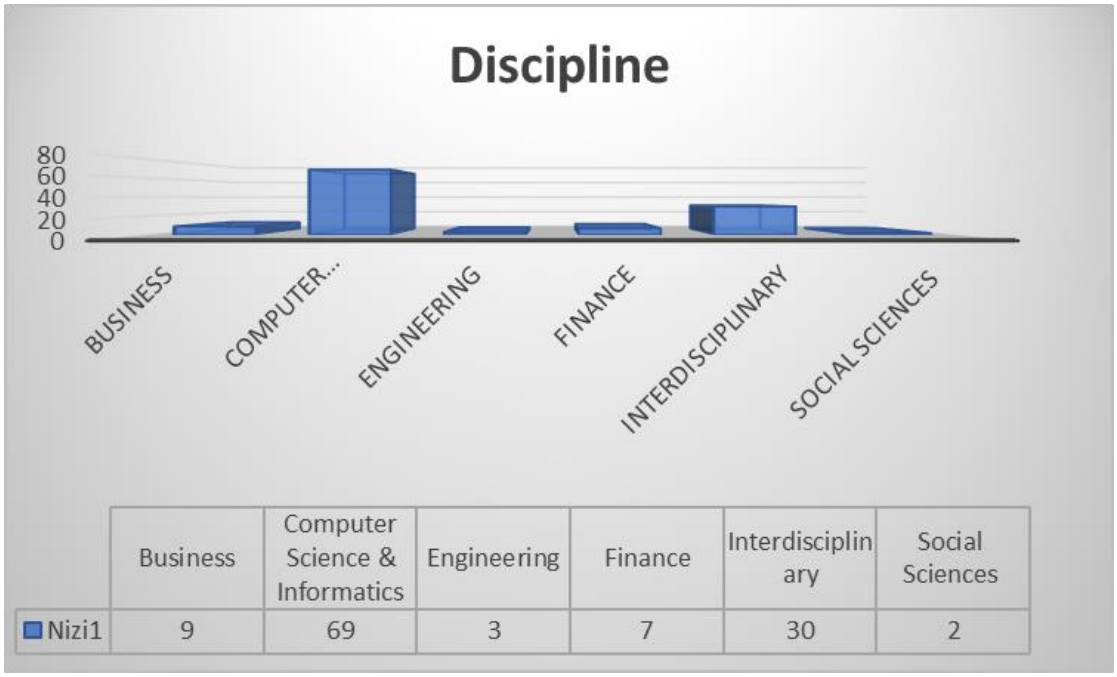
Figure 1 – Providers by legal status

Courses by Country:

- Austria: 2
- Belgium: 12
- Bulgaria: 7

- Cyprus: 1
- Czech Republic: 2
- Denmark: 1
- Estonia: 17
- France: 5
- Germany: 12
- Greece: 9
- Italy: 14
- Netherlands: 2
- Slovenia: 13
- Spain: 12
- Sweden: 1
- United Kingdom: 2
- Not specified: 9

Discipline:



	Business	Computer Science & Informatics	Engineering	Finance	Interdisciplinary	Social Sciences
Nizi1	9	69	3	7	30	2

Figure 2 – Discipline

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Type of Learning:

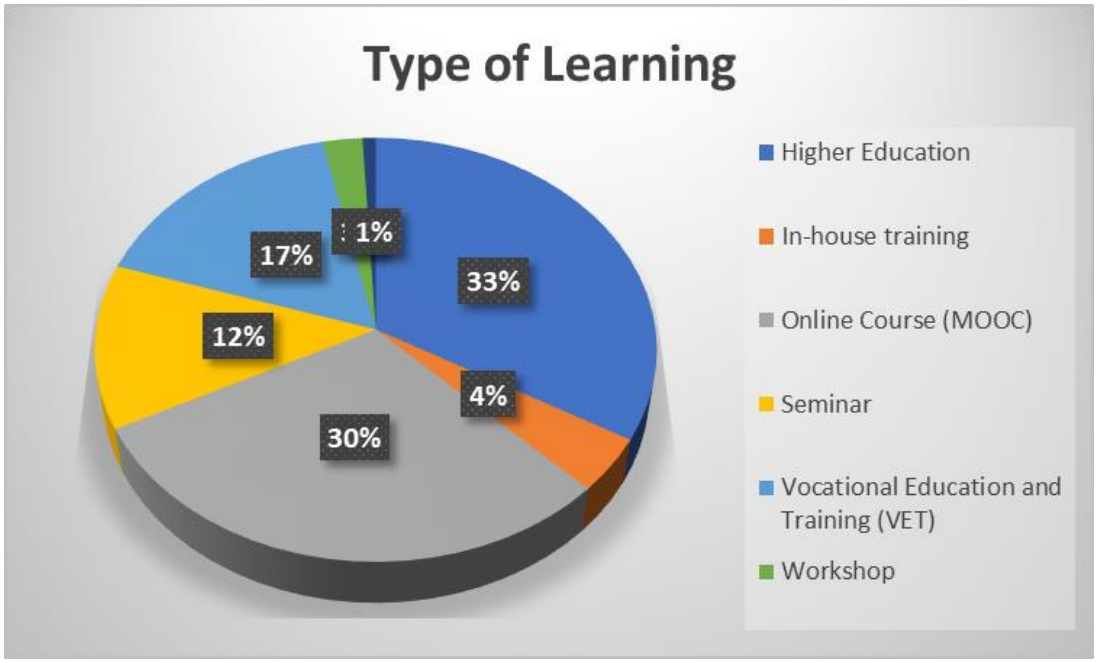

Figure 3 – Types of learning

- Higher Education: 40
- In-house training: 5
- Online Course (MOOC): 36
- Seminar: 15
- Vocational Education and Training (VET): 20
- Workshop: 3
- Others: 1

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Course Level:

Figure 4 – Course level

- Beginner: 50
- Intermediate 22
- Advanced: 28
- Other: 20

2.3 Online survey

Number of valid responses: 317 (target 520)

On question “How would you characterise the primary purpose of Blockchain within your organization?”, 146 have answered that they are primarily providers of Blockchain/DLT Services, 107 are users of Blockchain/DLT Services and 64 are on both sides.

Most responses came from Ireland (46), Estonia (44), followed by Germany (43), and France, Greece and Italy with 27 responses. 89 respondents did not indicate their country of origin.

2.3.1 Company’s profile

- 37% operate in the ICT sector, 13% in financial services, 12% in education, 5% in research, 3% in public services and 28% in other sectors

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- 34% have 10 or less employees, 21% have 50 or less employees and 14% have between 51-200 employees
- 60% have 0-20% share of employees working on or related to BC digital assets projects while 17% of the responding organisations have 80-100% share
- In 65% of the organisations the average level of education in the BC team is Postgraduate and 23% Undergraduate
- In 67% of the organisations the share of women working in BC is under 20%
- In 37% of the organisations the average age of BC employees is 26 – 30 years and in 30% is 31-35 years
- 51% of the organisations encountered difficulties in recruiting staff with the required set of BC skills and knowledge
- 37% operate in the ICT sector, 13% in financial services, 12% in education, 5% in research, 3% in public services and 28% in other sectors
- 34% have 10 or less employees, 21% have 50 or less employees and 14% have between 51-200 employees
- 60% have 0-20% share of employees working on or related to BC digital assets projects while 17% of the responding organisations have 80-100% share
- In 65% of the organisations, the average level of education in the BC team is Postgraduate and 23% Undergraduate
- In 67% of the organisations, the share of women working in BC is under 20%
- In 37% of the organisations the average age of BC employees is 26 – 30 years and in 30% is 31-35 years
- 51% of the organisations encountered difficulties in recruiting staff with the required set of BC skills and knowledge

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3 Qualitative skill-supply analysis

3.1 Blockchain skill-provider perspective

3.1.1 Current status

3.1.1.1 Blockchain skills supply

An analysis of the responses showed that the supply of trainings/courses in the field of BC technology is increasing. Respondents point out that due to the relatively low interest of companies in the field of BC, the development of training programs is slower than expected when the Blockchain technology was introduced.

As part of the desk research, 120 programs were identified in the field of developing Blockchain skills.

From the point of providers of BC education, the following areas have to be covered (programmes/courses):

- Infrastructure, SW distributed architecture, decentralised SW architecture, P2P
- DLT, Distributed Ledger Technology
- Deep analysis of use cases: Bitcoin, Ethereum, Cardan, Ada, Polka Dot and their applications/evolutions
- Smart contract & token economy
- Self-sovereign identity (SSI)
- Decentralised business models for enterprise & citizens' networks, both at local, national and international level
- Cooperation game theory and transferrable utility
- Distributed consensus, decentralised architectures' economy
- Decentralised Finance (DeFi)

The responses of companies that participated in in-depth interviews and in the online survey shows that companies have a demand for BC experts, but do not have the option to hire them. For this reason, companies identify mostly IT experts and train them in the field of BC technology. In the current situation, we cannot talk about a larger, functioning human resources market in the BC area.

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- *Fora*

Target group

Target Groups	Total number	%
Ethereum users	2	11,76
Developers	4	23,53
Managers, HR	1	5,88
Blockchain stakeholders	5	29,41
Bitcoin users	3	17,65
Crypto currency users	2	11,76
Total	**17**	**100,00**

Table 2 – Target group

Topic

Topic	Total Number	%
Bitcoin	4	23,53
Blockchain technology	4	23,53
Career development	1	5,88
Crypto currencies	5	29,41
Ethereum	2	11,76
Networking	1	5,88
Total	**17**	**100,00**

Table 3 - Topic

Geographical coverage

All Fora are international orientated.

Skills categories

Transversal skills

Scale	Total number	%
Not considered	16	94,12
Considered	1	5,88
Strongly considered	0	0,00
Total	**17**	**100,00**

Table 4 – Transversal skills (Skills categories)

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Technical Skills

Scale	Total number	%
Not considered	3	17,65
Considered	8	47,06
Strongly considered	6	35,29
Total	**17**	**100,00**

Table 5 - Technical skills (Skills categories)

Business skills

Scale	Total number	%
Not considered	5	29,41
Considered	8	47,06
Strongly considered	4	23,53
Total	**17**	**100,00**

Table 6 – Bussiness skills (Skills categories)

3.1.1.2 Educational and Training Programs

As part of the desk research, 120 programs were identified in the field of developing Blockchain skills.

The key areas covered by the programs are: Computer Science & Informatics, Interdisciplinary studies, Finance, Engineering and Social Sciences.

According to the COVID situation and the dispersion of participants, most programs are implemented online (80%), the hybrid model (on-line & classroom) is used in 15%, and in 5% of cases the programs are implemented exclusively in the classroom.

Regarding the level of the programs, most of them are intended for beginners (50), followed by advanced (28) and intermediates programs (22). In twenty cases, no assessment was made as to the level of difficulty.

Most common type of Learning is higher education (34%), followed by online course (30%), vocational education and trainings (17,5%), seminars (12,5%), in-house training (4%), workshops (1%) and others (1%).

Within the in-depth interviews, information was collected from experts in the design and implementation of blockchain skills development programs. Interviews were conducted with experts from Greece, Italy and Slovenia.

The provision of blockchain skills in the national education and training system is not structured and – generally speaking – not qualitative.

There are currently many courses on BC provided by universities, more as part of general education curricula rather than a specific BC course. At the same time, these courses are not very structured or very well defined, mainly because there is not a qualified or experienced formal trainer in the field of BC.

Some BC training is included in short courses or as part of a more general education curricula more on a theoretical approach with no concrete applications (linked with the lack of experienced trainers mentioned above).

Desk research (figures)

Type of qualification awarded

Type of Qualification Awarded	Total number	%
Bachelor Degree	3	2,50
Master Degree	31	25,83
PhD	2	1,67
Certificate of Attendance	13	10,83
Certificate of Completion	34	28,33
Certificate of Continuing Education	7	5,83
Vocation Education / Professional Diploma	13	10,83
Not specified	7	5,83
Total	**120**	**100,00**

Table 7 - Type of qualification awarded

Duration of the mode

Duration of the mode	Total number	%
1 day (up to)	14	11,67
2-6 days	31	25,83
1 - 15 weeks	25	20,83
Semester	10	8,33
1 Year	13	10,83
More than 1 year	14	11,67
Other / blank	13	10,83
Total	**120**	**100,00**

Table 8 - Duration of the mode

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Mode of study

Mode of study	Total number	%
Classroom based	22	18,33
Distance learning	58	48,33
Blended (classroom + distance)	37	30,83
Combined classroom-based and apprenticeship	3	2,50
Total	**120**	**100,00**

Table 9 - Mode of study

Target audience

Target Audience	Total number	%
General Audience	34	28,33
ICT Professionals	29	24,17
Blockchain Developers	7	5,83
Blockchain Consultants	2	1,67
Executive and Managers	8	6,67
Others / blank	40	33,33
Total	**120**	**100,00**

Table 10 - Target audience

Analyse Modules (lessons)

Transversal skills

Scale	Total number	%
Not considered	41	34,17
Considered	26	21,67
Strongly considered	36	30,00
N/a	17	14,17
Total	**120**	**100,00**

Table 11 - Transversal skills (Analyse Modules)

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Technical skills

Scale	Total number	%
Not considered	1	0,83
Considered	19	15,83
Strongly considered	83	69,17
N/a	17	14,17
Total	**120**	**100,00**

Table 12 - Technical skills (Analyse Modules)

Business skills

Scale	Total number	%
Not considered	53	44,17
Considered	18	15,00
Strongly considered	32	26,67
N/a	17	14,17
Total	**120**	**100,00**

Table 13 - Business skills (Analyse Modules)

Intended Learning outcome

Transversal skills

Scale	Total number	%
Not considered	32	26,67
Considered	33	27,50
Strongly considered	20	16,67
N/a	35	29,17
Total	**120**	**100,00**

Table 14 - Transversal skills (Intended Learning outcome)

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Technical skills

Scale	Total number	%
Not considered	7	5,83
Considered	21	17,50
Strongly considered	57	47,50
N/a	35	29,17
Total	**120**	**100,00**

Table 15 - Technical skills (Intended Learning outcome)

Business skills

Scale	Total number	%
Not considered	40	33,33
Considered	27	22,50
Strongly considered	18	15,00
N/a	35	29,17
Total	**120**	**100,00**

Table 16 - Business skills (Intended Learning outcome)

Discipline

Discipline	Total number	%
Computer Science & Informatics	**69**	57,50
Interdisciplinary	**30**	25,00
Finance	**7**	5,83
Business	**9**	7,50
Social Sciences	**2**	1,67
Engineering	**3**	2,50
Total	**120**	**100,00**

Table 17 – Discipline (Intended Learning outcome)

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Provider Legal status

Types of providers	Total number	%
Private	**88**	73,33
Public	**29**	24,17
Others	**3**	2,50
Total	**120**	**100,00**

Table 18 – Provider Legal status (Intended Learning outcome)

Course Level

Course Level	Total number	%
Beginner	**50**	41,67
Intermediate	**22**	18,33
Advanced	**28**	23,33
Other / blank	**20**	16,67
Total	**120**	**100,00**

Table 19 - Course Level (Intended Learning outcome)

Programme Orientation

Programme Orientation	Total number	%
General	**43**	35,83
Subject-specific	**56**	46,67
Sector - specific	**12**	10,00
Combination	**9**	7,50
Total	**120**	**100,00**

Table 19 - Programme Orientation (Intended Learning outcome)

Education level of participants

Education level of participants	Total number	%
Non	7	26,92
Bachelor's degree	9	34,62
Master degree	9	34,62
Ph.D.	1	3,85
Total	**26**	**100,00**

Table 20 - Education level of participants (Intended Learning outcome)

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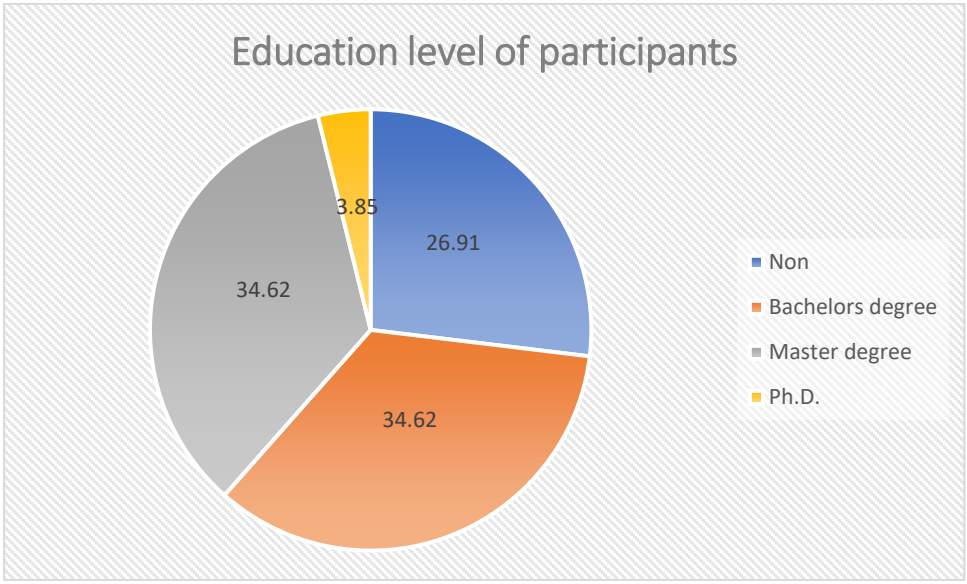

Figure 5 – Education level of participants

With an online tool, we analyzed the incidence of each program/area (words). We designed 4 graphs: No. 1 - represents the analysis of all programs, No. 2 - BC networks, No.3 – BC technologies, and No.4 - areas of application.

The graph shows the most frequently mentioned areas/words of BC training (word size is related to the number of citations):

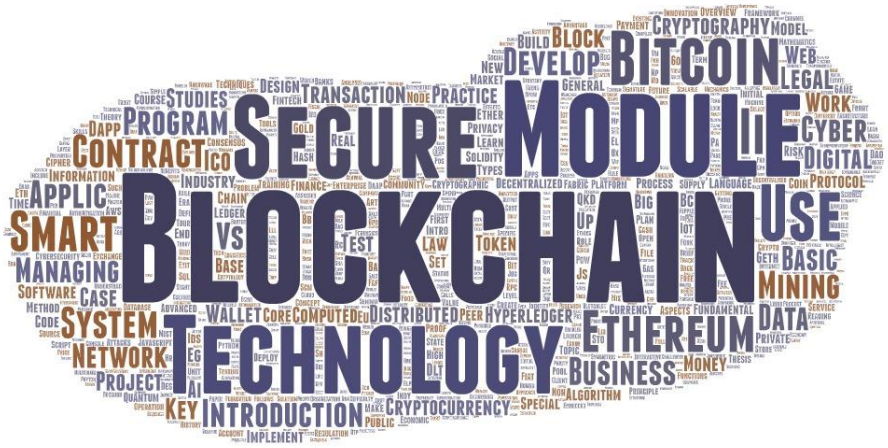

Figure 6 – the most frequently mentioned areas/words of BC training

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Blockchain networks (word size is related to the number of citations):

Figure 7 – Blockchain networks

Technologies (word size is related to the number of citations):

Figure 8 – Technologies

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Areas of application (word size is related to the number of citations):

Figure 8 – Areas of application

In-Depth Interviews - providers

1. Blockchain Skill Development on a national level/ Policy Level:

- **Are specific qualification frameworks/ programs/ measures existing on a national or regional/ subregional level in EMS which are specifically aiming at supporting BC Skill development? (e.g. through associations, qualification agencies, professional associations, from state actors, policy makers, etc.)**

The research showed that none of the included countries (Slovenia, Italy, Greece) have National education and training systems that would cover the contents of Blockchain technology in a structured and comprehensive way. There is also no national framework in these countries that guides or sets the framework for the design of such programs. There are initiatives from both the private sector and the public sector, but they have been created or implemented based on personal enthusiasm, demand, and market needs.

The existing program is mostly divided into two groups, and can be compartmentalized into the group "General knowledge of blockchain technology" and "Specialized program".

There were no differences between countries on this issue.

- **How is the institutional structure of skill provision related to BC skills organised on a national level? Who are the responsible actors to support BC relevant skill development? Can different strategies be identified and described?**

According to the interviewees, there is no structured approach to the topic. Responsible actors are not clearly defined or do not carry out activities in these areas. There are certain initiatives (Italy), but they do not give satisfactory results or directions for further development in the field of BC technology training programs.

The initiators or providers of the programs are mostly in the University environment (faculties), and these are shorter courses within other programs or fields of study.

No strategy has been identified in any country (does not exist).

There were no differences by country on this issue.

- **From a policy viewpoint: What are the needs for qualification within the field of BC relevant skills today and in the near future?**

The needs definitely exist. The interviewees pointed out the need for a profile of employees who will be able not only to technically implement projects but also to recognize the needs of individual industries and "understand" the interlocutors on the client-side, who will not have a technical background.

The following were highlighted: DLT (Distributed Ledger Technology, Self-sovereign identity (SSI), Decentralized Finance (DeFi), Smart contract and token economy, Infrastructure,…

There were no differences by country on this issue. In the case of the answer from the Italian partner, specific areas of need were listed (1. interviewee), while the answers of the other interviewees generally assumed the need for such knowledge.

2. Blockchain Skill Development through Institutions & E&T Program (Providers)

- **Are specific formal qualification programs existing on an institutional level in European Member States (EMS) which are specifically aiming at supporting BC Skill development? (e.g. VET or academic Programs with specific explicit BC skill related focus, short courses with specific BC skill related focus, further & ongoing qualification offerings/ weekend courses/ online courses with a specific BC skill related focus)**

There is no formal program. There are currently two types of programs on the market. The first are courses at faculties, which are short, independent events or as one of the contents within other study programs. Another form is courses conducted by private institutions that generally cover the contents of

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BC technology or are focused on a specific part of BC technology or solutions with the help of BC technology.

According to the answers, independent master's studies (University of Thessaloniki) are carried out only in Greece.

Differences between countries are shown here in the program providers or locations (faculties) where the program is implemented. As already mentioned, the regular program is implemented only in Greece. In Slovenia, they exist as a part of other programs, the content is implemented at the Faculty of Electrical Engineering and Information. In Italy, the subject is also implemented at the Faculty of Law.

- **Analysis of VET courses and programs: Which BC relevant skills are implicitly and explicitly currently embedded into the curricula of and provided through formal VET courses OR provided by ICT companies or other online courses or seminars?**

Interviewees do not have this information.

The common opinion is that this would be necessary - the inclusion of BC content in the Curricula. A large number of private initiatives are mentioned, but they should be certified, as this would ensure quality. The contents of the aforementioned programs mostly include content from the field of Crypto-currencies.

A lot of knowledge and information is also provided in the framework of Open Source communities that develop such technologies (Ethereum Foundation, Polkadot, Cardano, etc.).

According to the interviewees, there are no official certified programs in the field of BC technology. It is possible to receive a certificate of participation, which, however, has no formal value.

- **How is the importance of BC relevant skill development reflected within the entire area of ICT relevant skill provision through seminars, online courses, VET programs and/ or academic programs?**

This question was answered by 4 out of 7 interviewees. The answers were uniform, as everyone believes that there is not enough such content or independent programs. The contents are included to a lesser extent in other ICT study programs. Inclusion depends on the professor in charge and in many cases blockchain is not part of the official curriculum.

- **Is there a seamless provision of upskill-offerings within the formal education sector or are there structural barriers for IT professionals to become upskilled?**

The main obstacle was the lack of quality, comprehensive programs in the field of BC technology. Another obstacle is the slow adaptation of HPP programs to development trends in this area.

Most competencies are developed/acquired in the market when concrete challenges in project implementation are addressed.

It was pointed out that the certification of programs would bring added value for potential beneficiaries of the programs, as on the one hand they would have guaranteed quality, and on the other hand motivation in achieving an additional formally recognized qualification.

3.Now let's turn to teaching/ learning aspects…: From your experience

- **What are successful/ appropriate ways/ concepts to teach BC relevant skills?**

Most of the answers (6/7) advocate a combined approach that includes a formal part and a practical part (learning by doing). It is pointed out that a 2-phase approach would be recommended, whereby phase 1 includes theoretical knowledge or basics of BC technologies, while the second phase would represent the use of acquired knowledge to perform specific tasks. The inclusion of good practices is recommended.

The added value would be the inclusion of experts/needs directly from the market and the inclusion of videos in online training.

- **Which role is formal training and teacher-cantered approaches vs. peer-learning approaches playing?**

There are different views here. Experts from Greece prefer a formal approach, which should be more comprehensive and better structured. On the other hand, experts from Slovenia and Italy advocate learning by doing or a combined approach.

- **How is the important role of future skills/ soft skills reflected within the education/ training programs?**

In any case, soft skills are needed and their long-term integration enables the achievement of a broader consensus and operational success. This is especially evident in the operation of networks, clusters, or other self-regulated communities with no "governing" authorities or third partners.

Currently, soft skills are not included in a lot of formal VET programs.

- **What BC skills level are you addressing? (Introductory, intermediate, advanced)**

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The interviewed private providers offer both general-basic knowledge, as well as advanced programs. Providers from public institutions, within their programs (not individual counseling), offer initial and intermediate programs.

- **How do teachers/ trainers gain the necessary qualification to support learners in developing BC relevant skills? (Are BC teachers assuming a role of coaching rather than knowledge bearers?)**

There are no programs that would allow teachers to acquire certified knowledge in the field of BC technology. In any case, it would be necessary to enable the existing staff at the HPP to acquire knowledge from the BC field, which would, in addition to the theory, also contain a practical approach.

- **Which role do official/ formal certifications play for BC relevant skill supply?**

At the moment, there are no programs that would allow you to obtain an official certificate. Respondents agree that certification is necessary for the further development of the field and the formal regulation of professional profiles in the field of BC technologies.

It was also pointed out that a certain part of the environment sees BC technology, only as a possibility of earning (Crypto) and not so much as the next stage of development in the field of technologies.

- **Are there certificates for BC professionals? (Certificates, micro credentials, alternative credentials)**

No answer.

- **Which are the usual formats for education and training offerings to support BC relevant skill development (online, offline/ asynchronous, synchronous, blended)?**

Online (2) or blended (5).

4. In-house blockchain training provision

- **Relations between Business and Education**

There are no structure cooperation between Business and Education in the field of BC technologies. There are some pilot projects (Italy) in the field of startup / spin-out companies from universities. Companies find experts themselves and hire them directly to conduct workshops / consulting. Experts (there are few of them) from academics are not recognizable to companies.

- **Ways organizations use to develop/grow its workforces blockchain skills**

Experts from Greece cited online training.

In the case of Slovenia, there were no answers.

- In the case of Experts from Italy, however, they pointed out that the training is conducted by BC experts from the economy and that it is crucial to build cooperation between these sectors and highlight the advantages of both, such as practical experience and up to date knowledge with a structured approach and the possibilities of the available research infrastructure.
- **Effective ways to organize/provide Blockchain training within organizations?**

Blended (online and classroom training). In a combination of experts from the theoretical part of BC technology and experts with practical experience.

5. Informal blockchain skills development

- **Tools, communities and for a professionals use to further educate and upskill themselves to Blockchain relevant skills**
- Certainly, communities and forums are good sources for gaining information, knowledge, and connections in the field of BC technology. In all countries involved, they exist, but most have limited reach in terms of content integrity and professionalism. It was pointed out that an online approach involving gamification in the use of digital platforms is an important channel for knowledge transfer and that innovative startups can play an important role (in cooperation with national institutions) in the development of VET programs in this field.

- **Recognition and validation of Blockchain relevant skills acquired in an informal way.**

This sector has to be developed.

Italy

Experts believe that it would be very useful to create a National Community where the available competences are mapped and matched with the labour market needs, while at the same time providing support for the learning by doing and skills' sharing at all levels.

BC is reaching out its mature phase of development and has been used as an enabling technology in a number of cases, including in the public sector (ex. the EBSI).

Most of the competences are developed in the field, by business and/or technological start-ups by specialized competences.

Such a community, which can be labelled as “Blockchain Skill Hub”, should work as the interconnection and matchmaking point also using a “tokenization” model.

In Italy there are lectures on BC as a part of other subjects in the formal college program and live daily courses, but there is not a large demand for content in this area. The courses offer an overview of the subject BC, an overview of specific technologies and decentralized applications on Ethereum and smart content.

Slovenia

Currently in Slovenia there are no formal frameworks to recognize and developing a subject for blockchains is not viable in a classical university, there are other options in the private sector. There are also no institutional structures, and the experts believe they are not necessary yet, the industry should develop it. The institution Think tank is discussing with the Ministry of education about creating an official program. So far programs are trying to cover many different aspects of crypto currency, trading etc. The wish is to raise the technological and trading literacy. Many different perspectives are needed for understanding the technology of blockchains. ICT and blockchains go hand in hand in our programs, as the experts believe that viable solutions only come through applying different types of knowledge. ICT seminars and other types of online education are about 30 BC. There are many obstacles in the process of learning about blockchains. Rapid development, lack of imagination and the novelty of blockchains all deter the learning of blockchains. The criminal aspect of crypto currency also created a stigma around the subject.

Greece

There are master’s degrees in Greece.

In Aristotle University of Thessaloniki there is an MSc titled Systems to ensure confidentiality in the internet of things using blockchain technologies, Security of Master’s Course at the Department of Informatics of the University of Athens Information Systems Introduction to Blockchain Science & Engineering

Also, the IIB Council, provides the Certified Blockchain Professional (C|BP) Training and Certification Program for Developers and Business Technology Professional

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- *National policy*

Common to almost all responses received in the online survey and from participants in in-depth interviews is, that they did not recognize the existence of a national strategy in the field of BC education development.

Further, they think that governments/ministries are not a competent actor for BC skills development and instead individual initiatives by HE, VET and private companies are the development engines in the field of BC skills programmes.

Educating policymakers on blockchain is the first step to supporting them. Regulations have a sensitive role to serve as they must protect the public interest without confining innovation. For achieving a balance between regulation and innovation, legal practitioners should be equipped with the fundamental concepts of blockchain. Another factor that education can ameliorate is the confusion and misconceptions caused by blockchain coverage by the media. Education programs could aid legal practitioners to formulate an informed view about blockchain.

It is necessary to define a definition of skills provision for BC in the national education and training system.

The MiCA regulation and pilot regime is an initial step towards creating a unified legal framework within Europe. But it should be noted that these regulations along with other regulations may not be in place for the future changes that blockchain will bring. The major change that blockchain will bring is decentralization which is a novelty to traditional policies. Traditional policies are relying on centralized entities and pose requirements for these entities. The case is the same in MiCA regulation that focuses on crypto-assets issuers. On the other hand, blockchain envisions abolishing intermediaries and adopting decentralized structures. In short, traditional policymaking logic is not effective in decentralized structures and a novel approach should be devised.

Italy

AGID – the Agency of the Italian Government for the Digitalisation of the Public Sector is trying to promote the application of BC as part of the digitalisation strategy. However, no skill development is provided and also the people working in this office receive their training on the job by senior officers who developed their BC skills on the job.

An Italian Blockchain service Infrastructure IBSI – has been announced in March 2021 as a joint initiative by AGID, Poste Italiane (Italian Public Postal Service), Infratel, INPS (Italian Social Security Agency) and some Italian Polytechnics. They aim to create the first Italian network based on BC to offer public services, including qualification (CIMEA is partner of the initiative to handle this part).

There is not a national strategy for BC skills. The launch of an initiative at Governmental level to draft such a strategy has been discussed informally and not confirmed or officially launched yet.

There is a sort of informal agreement to cooperate along some main strategic directions which emerge as the spontaneous cooperation between middle to high professionals and BC expert; being a small community they tend to discuss and cooperate on open issues. This could be the seed for a future bottom-up national strategy on BC, should the Government be interested to include them in the drafting.

Slovenia

National strategies for Blockchain skills development are not existing.

Key figures in the informal field are FERI (University of Maribor), FRI (University of Ljubljana) and Blockchain think tank - there are no structured formal options.

Government funding on this subject is lacking and making the creation of a subject in this matter difficult. Slovenia had many companies that succeeded by using blockchains, however, Slovenia has not systematically supported these efforts. A large obstacle is the lack of an official program on BCs.

In the future, we need to diversify the use of blockchains into different fields, however, the officials are still mainly concerned about the illegal aspect rather than the opportunities the technology holds. But there are some advances being made in that area, nonetheless. We believe that in future the importance of having a group of experts originating from different fields and a common language of said experts to be vital.

Currently there are no official frameworks in Slovenia, there are some partial educations, as the topic is included in educational programs concerning computer science, however an actual official program explicitly for blockchains does not exist.

Greece

In Greece, skill provision is traditionally centred around higher education institutes. Universities are responsible for formulating their curriculum to answer the market needs. Regulations have a sensitive role to serve as they must protect the public interest without confining innovation.

In Greek there is no national strategy in the field of BC education development.

3.1.2 Characteristics of Blockchain Educational and Trainings programs

3.1.2.1 Trends

It is necessary to look at trends from two perspectives. The first is the development of new content/programs of BC technologies and their implementation.

The obtained data shows that the need for cooperation of educational institutions and companies in the field of BC program development is /will be urgent. Trends clearly show that needs are changing and that programs need to be constantly updated. The analysis showed that in the future, the market expects training to be phased. The basic phase will be basic knowledge in the field of BC, and further education modules will have to be adapted to specific areas and challenges of BC.

The teachers/trainers will be reliable in their role if they have applied their competence on the field, including complex/pilot cases. At academic level, professors must demonstrate operational professional experience in the field.

There is a strong need to develop BC skills by trainers/professors. There are few experts in BC. They are mainly experts in engineering (and some in banking and finance).

Another point around education is the need for institutes to provide ongoing education.

Trends also indicate a great need for experts who are not from technical background, but have the specific knowledge (finance, insurance, logistics…) needed for effective communication between customers and providers of solutions in the field of BC.

The second view is BC technology in the field of training provision, as a tool.

Online education is a new model of education, accelerated by Covid – 19. However, this mode of education still has many problems in terms of credibility, credit certification and certificates, student privacy, and various courses.

3.1.2.2 Teaching/ learning approaches

Because of the COVID situation and the dispersion of participants of BC courses most of the programs are implemented on-line (80%), the hybrid model (on-line & classroom) is used in 15%, and in 5% of cases the programs are implemented exclusively in the classroom.

The format for education generally combines formal training (online) and some workshops or use cases implemented either individually or in small groups.

Blockchain is in a new mindset and a new model for interaction and cooperation which is based on the digital technology.

Experts agree that workshops are very effective. A group of people searching for a solution by looking for information is one of the best ways of teaching. The hackathons are also a great way of making people learn about the subject. Human interaction is crucial for these types of teaching. The traditional teacher student model is also useful but is not compatible with learning expert level skills. Soft skills are vital for this way of teaching. Motivating and leading groups are crucial and often overlooked in traditional colleges.

Learning from real world examples helps students comprehend the material. A lot of BC training providers favour the peer style of learning compared to the teacher approach, as they believe that learning from a person who made a lot of mistakes makes more sense than learning from someone who has not made one.

Blockchain ecosystem attracts people of various academical fields. For instance, legal practitioners must familiarize themselves with the technology to formulate legal frameworks and legislations.

The approach teaching someone should be soft, the educator should be patient and should have many different answers for the same question, depending on the students' level of understanding. Learning through practice is essential as it helps with developing the skills to adapt to different clients and unique problems.

3.1.2.3 Certifications of programs (formal, in-formal)

Regarding official program certification, for the first time, major differences in responses emerged. Thus, we can extract data that show that even within the education providers, there are differences between those who prefer certification and those who believe that certificates do not matter at the moment. Proponents of certification are as expected coming from universities.

BC program providers issue certificates/notes of participation and similar documents to their participants as certifications also play a role as motivation for the learner.

It was also revealed that the BC training is currently seen as a commercial/business opportunity, so releasing the certification on BC might be adopted only as a way to make money, and the inclusion of certificates/micro credentials into wider ICT training might be useful.

There are currently no format blockchain certificates which qualify a teacher to be a professional coach.

The common denominator is that the need for certification of programs and certification of teachers/trainers, is very high. This step is also meant to have a more comprehensive approach to BC education and to help speed up the use of BC technologies in everyday life.

3.1.2.4 Type of providers of Blockchain knowledge

The desk research shows that more than 73% of content providers come from the private sector and the remaining 24% from the public sector and 3% from others.

The analysis clearly points to the fact that private program providers have a key and leading role to play in the development of this area at this time.

In the case of private providers, the group is very heterogeneous, as it includes colleges, laboratories, companies and initiatives.

3.1.3 Characteristics of Blockchain experts, educational and trainings - provider view

Individuals interested in blockchain, and BC experts are from the different scientific fields. For this reason, two actions must be taken to re-educate the workforce. The first action is to acknowledge the professional scientific field of individuals. Individuals from different fields can have different views and glossary on blockchain. The second is to deliver custom-made education for the individuals to understand the fundamentals of the technology. To make this process easier, organisations must recognize the particular set of skills based on the job positions and their subsequent tasks. As fundamental knowledge is present, organizations and individuals can dive deeper into the specific aspects of technology and the cooperation will be harmonized between the different practitioners.

Knowledge sharing inside companies usually comes in the form of one employee learning and teaching the knowledge to others. The other way is if the company receives a project that requires BCs. There are no BC development programs that currently exist.

3.2 Blockchain industry perspective

3.2.1 Blockchain skills in demand

3.2.1.1 Blockchain skills that are currently in demand

- The basic concept of how blockchain works
- Core software development skills
- Software architecture design and development.
- Management of blockchain-based applications
- Domain expertise (legal, finance, medical, etc.), digital identity, digital currency, data privacy, data management, and protection
- IT: digitalization, algorithms, data structures, network protocols, IT operation management, IT administration, IT systems management, IT security
- Programming skills: C++, Rust, JavaScript, Google Go, Python, solidity language
- Transactions, smart contracts, business model innovation
- Mathematics, cryptography, data science, data analytics
- AI
- Big Data
- UX Design/Design-thinking competence
- Team-working ability/Communication competence/problem solving /perspective taking
- Skills in legal compliance matters
- Skills for cooperation with the clients
- Communication competence
- Business development skills/Skills for BC use case development
- Coding/BC solutions design
- Product management skills
- Responsibility-taking/Perspective-taking
- Transversal skills

3.2.1.2 Blockchain related occupations that are currently in demand

- BC expert
- DevOps developers
- Banking sector expert

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- Media sector expert
- Law
- Marketing expert
- Big data analysts
- Project manager
- Specialized platforms experts
- Developer of BC applications
- Front-end developers, UX Designer
- Cloud architects
- Cybersecurity experts / Auditors
- Experts (not BC) implementing BC technology in other sectors
- Transformation manager
- NTF creation

3.2.1.3 Level of education and qualifications associated to Blockchain related occupations

Minimum level required:

- Non (31%)
- Bachelor's degree (33%)
- Master's degree (33%)
- Ph.D. (3%)

3.2.1.4 Shortages of Blockchain skills in the labour market

- Project manager & cooperation skills
- UX designer
- Developer
- Specialization in programming languages
- Legal expertise
- Domain experts

New technology – not much experience/skills exist on a market. There is a lack of courses in the BC field. It is not possible to hire an expert, the companies must train their employees.

3.2.1.5 Blockchain related skills today and in the future

Future (section 1.2 plus):

- Communication skills (technical/non-technical field)
- Project manager & cooperation skills
- Self-reliance and self-motivation
- Responsibility
- Ability to develop user-friendly tools
- Token engineering
- New business models
- Global view of BC market

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4 The profile of blockchain employees and recruitment realities

4.1 Definition of the Blockchain employee. Blockchain relevant occupational profiles

- BC expert
- Smart contracts expert
- Web developer
- Test engineer (truffle)
- Software engineer
- Architecture expert
- Mathematicians
- Project manager
- Communication manager
- Web3 developer
- Traditional job profile with interests in BC/DLT
- DevOps developer

In two cases, the responses stated that the BC profile does not yet exist at this time and that it is necessary to first develop a definition of the expert and programs for educating and certificates to acquire knowledge in the field of BC technology. A typical employee in the field of BC development is an expert in the field of programming (IT), who acquired additional competencies in the field of BC by participating in short seminars, analyzing existing literature, and doing practical work in the field/projects.

4.2 Characteristics of the Blockchain labour market (type of employment, type of

- Type of employment: regular
- Type of contract: full time (preferably) / Short term contract
- Level of wage:
    - 70.000 EUR – 80.000 EUR / per Year (Germany)
    - 800 EUR / day USA
    - other countries 35.000 EUR (junior) to 65.000 EUR (senior) per Year
- Gender: male (up to 20% women) / usually younger men
- Age: 25 - 35

- Educational level: University level

4.3 Most needed hard/technical skills for a Blockchain employee

- Architecture of BC
- Blockchain platforms
- Web3 developer
- DevOps developer
- Programming languages
- Integration of BC technology into other technologies
- Security
- Legal
- Connecting technical and business field
- Data modelling
- Coding
- Big data
- UX design

4.4 Most needed soft/interpersonal skills and qualities for a Blockchain employee

- Creative thinking
- Remote work
- Teamwork
- International English
- Project management
- Communication
- Organization
- Self-motivation
- Adaptability
- Solution-oriented
- Public speaking
- Product development
- Business analysis skills
- Legal skills

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4.5 Recommended previous experience and other requirements for a Blockchain employee

- Good experience in IT skills
- BC experience
- Web development
- Eagerness to learn
- University education
- Understanding of digital tokens
- Understanding of the basic paradigms of BC
- Business modelling

4.6 Difficulties in recruiting employees with the required set of Blockchain related skills

- Lack of staff with BC field experience
- Lack of VET programs (BC field)
- Need for in-house training
- Missing governmental strategy
- The problem of defining expectations to potential employees
- Lack of motivation/passion of potential employees
- Main set (no economical thinking)

4.7 Qualifications in demand for blockchain relevant positions

Minimum required level:

- Non (6)
- Bachelor's degree (8)
- Master's degree (1)
- Ph.D. (0)
- n/a (12)

Experience in:

- Ethereum
- Hyperledger
- Quorum
- App developing
- Generic science
- Domain knowledge

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5 Blockchain skills development and education provision

5.1 Appropriate VET course's structure and educational pedagogies to best support Blockchain skills development

Online platforms, vocational training from 3 -6 months, etc. The lectures should be in-person lectures not only online. The lectures should be divided into chunks to deal with specific tasks every week. The courses should be certificated.

Courses:

- General BC technology
- Practical approach (learning by doing – real cases)
- Focus content / specialized (business, legal, logistic, medial, creative thinking)
- Modular structure
- Mentors

5.2 Other formal, non-formal and in-formal activities that can support Blockchain skills development

Other possibilities for BC skills development:

- Senior employees train new employees
- In-house training
- Blockchain literature
- Online tools
- Peer - learning
- External training
- IBM Garage
- Working in SCRUM-based decentralized teams
- Cooperation between universities and BC companies
- Online MOOCs
- Meetups with local BC developers
- You tube
- Fora's

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5.3 In-house Blockchain training provision. Modes currently employed to grow workforce Blockchain skills in own company

- Senior employees train new employees
- In-house training
- Sharing of information – weekly meetings
- Literature
- Pilot projects
- Meetups with local BC developers
- Hackathons
- Peer learning
- Online courses
- Training on the job
- Time to learn (employees)
- Permanent training courses on the latest technological innovation

5.4 How shall companies internally plan and support BC development skills

- Within the cooperation with universities
- Increase interaction between learners and experts
- Creation of personal development/education program for each employee
- Taking part in projects on developing BC skills (BC Italia)
- Support employees taking classes
- Pilot proof on concept
- Advisors from outside of the company

5.5 Drivers of change

Micro and macro-environment developments that affect the demand for Blockchain skills, and Blockchain related occupational roles. How companies shall respond to these changes in terms of skills development, in-house training provision, and recruitment.

- Combining BC with other enabling, disruptive technologies
- Dedicated capabilities mastering the technologies

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- High level training for decision makers and non-specialists
- Continuous verification of the possibilities of BC technologies in business
- Reforming the mindset that BC is another word for crypto currencies
- Creating interactive hand-on course structures not only for IT experts
- Building IT and business infrastructure
- More automatization
- Entrepreneur leadership – new approaches
- Create the right environment
- Develop growth mindset

Survey:

210 companies (66,2%) are using BC technology in their business, more then 33% will start to implement BC technologies in next 5 Years. From 317 companies, 146 are providers of BC technologies, 55 are users and 64 are in both roles.

On the question about the importance of BC technologies at the present moment, 40% answered that BC in very important, and 5% think that BC in not important at all. More than 66% of companies are convinced that in the next five years BC will be very important.

BLOCKCHAIN SKILLS IN DEMAND

In the online survey and in-depth interviews, the companies identified the following key areas or knowledge in the field of BC skills:

- The basic concept of how blockchain works.
- Core software development skills.
- Software architecture design and development.
- Management of blockchain-based applications.
- Domain expertise (legal, finance, medical, etc.), digital identity, digital currency, data privacy, data management and protection.
- IT: digitalization, algorithms, data structures, network protocols, IT operation management, IT administration, IT systems management, IT security.
- Programming skills: C++, Rust, JavaScript Google Go, Python, solidity language,
- Transactions, smart contracts, business model innovation.
- Mathematics, cryptography, data science, data analytics.
- AI

- Big Data
- UX Design/Design-thinking competence
- Team-working ability/Communication Competence/problem solving /perspective taking
- Skills in legal compliance matters
- Communication Competence
- Business Development Skills/Skills for BC Use Case development
- Coding/BC Solutions Design
- Product Management Skills
- Responsibility-taking/Perspective-taking
- Transversal skills

Training approaches

Which training approaches does your organization use to develop/grow its workforce's Blockchain skills?	Total number	%
Acquisition	2	0,63
Development of Communities	9	2,84
External in-person-training (e.g., seminars)	6	1,89
Informal knowledge sharing strategies	2	0,63
In-house training courses	13	4,10
Mentoring	6	1,89
Online training	29	9,15
Recruiting	7	2,21
Other / blank	2	0,63
Combination of approaches	241	76,03
Total	**317**	**100,00**

Table 21 - Training approaches

"New work" and new leadership models

"New work" and new leadership models	Total numbers	%
Agile Frameworks (e.g. Scrum, etc.)	83	26,18
Self-managed teams	208	65,62
Holarchy organization	5	1,58
Democratic organization	12	3,79
Other / blank	9	2,84
Total	**317**	**100,00**

Table 21 - "New work" and new leadership models

Industry

Industry	Total number	%
Aerospace and Defence	2	0,63
Art and Culture	1	0,32
Automotive	1	0,32
Blockchain	1	0,32
Consulting	6	1,89
Construction	5	1,58
Cryptocurrency	1	0,32
Cyber Security in the military field and public services	1	0,32
Education	40	12,62
Energy	8	2,52
Events	1	0,32
Financial services	44	13,88
Food / Agriculture	4	1,26
Gaming	3	0,95
Healthcare	5	1,58
Information and Communication Technologies (ICT)	117	36,91
Legal	1	0,32
Manufacturing	8	2,52
Non-profit	1	0,32
Open innovation	1	0,32
Public services	10	3,15
Research	19	5,99
Marketing	1	0,32
Supply Chain, Logistics and Transportation	11	3,47
Tax & Audit	1	0,32
Other / blank	24	7,57
Total	**317**	**100,00**

Table 22 - Industry

BC usage

BC usage	now	%	in future	%
Yes	210	66,25	107	56,32
No	107	33,75	83	43,68
Total	**317**	**100,00**	**190**	**100,00**

Table 23 - BC usage

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5.5.1 Blockchain skills development – companies view

5.5.1.1 Trends

The trends that are being demonstrated or predicted by companies in the field of providing BC skills are moving in the direction of structuring the offer of educational programs, as only in this way can we ensure the development and wider use of BC technology in the long run. From the answers, it can be understood that companies are currently using a combination of external education and training within the company. At the same time, they emphasize that the importance is not only in the knowledge of BC technology itself, but that the main challenge is the ability to know topics such as logistics, business, banking.

In the future, providers of BC trained programs will have to design programs that will bring BC technology closer to non-informatics and thus educate staff who will not only technically master the field but will be able to communicate with clients or other departments.

The answers pointed out that there will continue to be a shortage of specific experts in the following areas:

- DevOps developers.
- Expert consultants (hard transformation/transition skills).
- Competent teachers/trainers.
- IT, algorithms, programming, data analytics, smart contracts, transaction management.
- New approach to coding; the usual runtime issue of coding turns into a smart contract performance issue (Coders must think more and more like financial managers)

In the future, the blockchain market will change so that being able to apply blockchain to provide business solutions will be the main requirement, instead of understanding the technology.

A global view of the Blockchain market and ecosystem, which is in constant evolution.

Using knowledge of various technologies, IT and Business managers will be crucial for competitiveness of the companies, as this technology allows to better overcome business and technical challenges, evaluate trade-offs, unlock new revenue streams, and implement change in the organization's information systems capabilities.

5.5.1.2 Teaching/ learning approaches

The analysis of the response showed that companies in the field of designing BC programs expect greater adaptation to the content of the direct needs of companies.

There is a gap between theory and practice. Often, one is able to develop a blockchain prototype but is not able to put it into practice (e.g. build a server architecture, etc). Blockchain classes would fit into software engineering or general engineering studies, and even basics could be taught in in more generic studies, e.g. management schools.

The companies prefer hybrid model of programs (online + class), because of easier time management for employees. They also expect that the programs will be as interactive as possible and discuss topics with real world business cases.

Trends show employees training with the help of existing employees, who will be well trained on the one hand, and on the other hand know the challenges and goals of the company very accurately.

An overall structure should be a modular structure. It should not be cohesive.

As a first step, a large number of companies mentioned the creation of various programs that would be a ticket for further acquisition of BC skills. Starting with fundamental (basic) courses that theoretically prepares employees for working in the BC field. To have a good system that combines a lot of theory with the smart contract system and other sectors of BC. The course should include basic math, statistics, basic software engineering, basic algorithm courses and also innovative and distributed thinking. And at the same time includes the following content: fundamentals about the blockchains, fundamentals of cryptography and consensus algorithms, novel methodologies for the actual design of blockchain solutions. It is important to add content about the nature of money and also economics.

The basic training will have to be followed by an advanced course, which will enable the acquisition of specific knowledge in the field of BC technologies and will thus solve the concrete challenges of companies.

5.5.1.3 Formal, non-formal skills development

The data obtained from the online survey, in-depth interviews indicate that companies advocate the use of both, formal and non-formal skills development approach. The background for such a decision is based on the following facts:

- There is a gap in the offered/searched contents.

- For the most part, formal programs do not follow the latest trends.
- Non-formal forms also enable the possibility of socializing and active exchange of opinions
- Different lengths of training.
- Different approaches to knowledge transfer (learning by doing, peer to peer, ..).
- The importance of acquiring basic knowledge in the field of BC (formal skills development)
- practical training and learning by doing are the best.
- Certainly, basic theory is required.
- The need to implement certificates and certificated programs.

A lot of companies do not have special professionals who teach employees about the development of blockchain or about blockchain in general. There courses are focused on e-learning like online courses, online resources. Companies should arrange a time to teach new employees about the concepts of blockchain and associated techs.

At the moment, companies mostly do learning by doing. The classical approach "I sent my employee to the learning courses, and we have certifications" - this does not exist or hardly exists at all. The industry for certifications does not really exist in the blockchains. But there is an attempt to develop programs with certified trainers at the universities and colleges.

5.5.2 The profile of Blockchain employee's – companies view

The answers of the respondents in the field of the current state of the situation and needs show the following characteristics of employees in the BC field:

- Employees have knowledge of:
    - web development (for example, programming skills) and concepts of the blockchain
    - IT, legal, finance, data
    - mathematics, statistics.
    - tokens, smart contracts
    - advance distributed system thinking
    - agile development methodologies
- Mostly they are full-time employees (part-time employees are students) or freelancers
- Looking for a free way of doing work (work from home, from another country, etc.)
- Have bachelor's or master's degree.
- Gender: male
- Age: between 25 and 35 years
- Average wage is higher than normal developers

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- Wages varies from region to region

5.5.3 Main characteristics in recruiting and up-skilling Blockchain staff

Research shows that there is a large gap between the needs and supply of experts in the field of BC technologies. Companies find it difficult to obtain qualified staff, so they often resort to their own training of the necessary staff. The lack of qualified staff is a serious problem for both companies and the entire BC industry.

Companies are primarily looking for two types of experts when posting jobs or finding employees. Experts in the field of IT and experts in the field of other sciences, whose content can contribute to the successful formation of solutions for the market, such as experts in the field of mathematics, finance, logistics, insurance and others.

In the field of upgrading BC knowledge, companies identify potential providers of education in individual areas of BC, they hire them to train a certain part of the staff, which further trains other employees of the company (train the trainers).

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6 Summary and findings

As part of the identification and analysis of the supply of knowledge in the field of blockchain technologies, we conducted 7 in-depth interviews with training providers, 26 in-depth interviews with companies, identification, and analysis of 120 BC training programs, reviewed 17 online communities and forums, and 317 online surveys.

- The summary of the situation in the field of BC training offers highlights the following findings:
- There is a gap in the offered/searched contents.
- There are no or no comprehensive national policies in the field of BC skills supply.
- For the most part, formal programs do not follow the latest trends.
- Non-formal forms also enable the possibility of socializing and active exchange of opinions
- Different lengths of training.
- Different approaches to knowledge transfer (learning by doing, peer to peer, ..).
- The importance of acquiring basic knowledge in the field of BC (formal skills development) /
- the basic theory is required.
- The need to implement certificates and certificate programs.

Research shows that there is a large gap between the needs and supply of experts in the field of BC technologies. Companies find it difficult to obtain qualified staff, so they often resort to their own training of the necessary staff. The lack of qualified staff is a serious problem for both companies and the entire BC industry.

A lot of companies do not have special professionals who teach employees about the development of blockchain or about blockchain in general. These courses are focused on e-learning like online courses, online resources. Companies should arrange a time to teach new employees about the concepts of blockchain and associated techs.

On the question about the importance of BC technologies at the present moment, 40% answered that BC is very important, and 5% think that BC is not important at all. More than 66% of companies are convinced that in the next five years BC will be very important.

Based on the above, we propose the following steps for the design of content and ways of acquiring knowledge in the field of BC technologies:

- Involvement of all stakeholders, with emphasis on the influence of companies in designing programs.

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- Launching national initiatives to design BC training programs, while ensuring the funding of these programs.
- Developing programs for acquiring basic knowledge in the field of BC technology.
- Design of programs (intermediate and expert) regarding development trends and the needs of the society (public sector, companies).
- Use of combined approaches in presenting knowledge from BC technologies
- Combining training programs at the level of groups of companies (it was pointed out that companies lose a lot of time because of in-house learning)
- Communication activities that will bring BC technologies closer to users (change of mindset that BC = cryptocurrencies).

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