



blockchain skills for Europe

## D6.1.1

**Blockchain Specialist  
Occupation Cards**

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## Abbreviations

BC	Blockchain
CEDEFOP	European Centre for the Development of Vocational Training
CoVE	Centres of Vocational Excellence
CRM	Customer Relationship Management
DLT	Decentralised Ledger Technology
ECVET	European Credit system for Vocational Education and Training
ESCO	Occupations - Skills & Competences -Qualifications
EQAVET	European Quality Assurance in Vocational Education and Training
EQF	European Qualifications Framework
ERP	Enterprise Resource Planning
ICT	Information and Communications Technology
ITC	Inter-company Vocational Training Centers
MOOC	Massive Open Online Course
MCQ	Multiple Choice Questions
NQF	National Qualifications Framework
VET	Vocational Education and Training
WBL	Work Based Learning

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# 1 EXECUTIVE SUMMARY

## 1.1 INTRODUCTION

CHAISE is a Sector Skills Alliance financed by the Erasmus+ Programme. Project's core mission is to develop a strategic approach on blockchain skills development for Europe, as well as to deliver future-proof training solutions, in order to tackle blockchain skill shortages and to respond to the current and future skill needs of the European Blockchain workforce.

Under WP6 "Occupational requirements, recognition and certification" the task T6.1 "Definition of Blockchain Specialist occupation" aims at the defining the EU-wide skills requirements for blockchain professionals based on the results from WP2, WP3 and WP4, and the subsequent creation of dedicated blockchain occupation profile, to be embedded into ESCO and ECQA classification systems.

## 1.2 OBJECTIVES

This Blockchain Specialist occupation card lays down a detailed set of attributes, including an explanation of the occupation in the form of scope note and definition, the sum of knowledge, skills and competences considered necessary for this occupation on an EU-wide scale, proficiency level, and eventually, the relevant qualifications awarded in education and training systems across Europe.

## 1.3 METHODOLOGICAL APPROACH

The target group of the CHAISE Occupational Cards includes qualification and accreditation bodies across Europe, qualification experts, VET providers, VET trainers and curricula designers in ICT field, as well as VET learners. The methodology followed for identifying and characterizing the relevant occupational profiles in the Blockchain Specialist domain is depicted in Tables 1 and 2.

Table 1 CHAISE research methodology

Blockchain labour market characteristics			
Blockchain Skill Demand	Quantitative research data	Qualitative research data	Blockchain Skill Supply
↓	<ul style="list-style-type: none"> <li>Survey data EU organizations</li> </ul>	<ul style="list-style-type: none"> <li>Interviews</li> <li>Desk research</li> <li>Database research</li> </ul>	↓
Blockchain Skills Capacity EU			
<ul style="list-style-type: none"> <li>Skills needs today &amp; in the future</li> </ul>			

- Skill development strategies
- Skill typology
- Training system of the future

Table 2 Key elements of the CHAISE research methodology

Definition of Skills Mismatches for the European Blockchain Sector				
Study on Blockchain labour market characteristics	Study on Blockchain skill demand	Registry of Blockchain job ads	Study on Blockchain skill supply	Registry of Blockchain educational and training offerings
Data collection and analysis of data from official statistical databases	In-depth expert interviews on Skills in BC sector		In-depth expert interviews with education & training providers of BC programs in Europe	
	Desk research on blockchain skill needs evidence		Analysis of existing formal & non-formal BC & education provision	
Study on relevant online job vacancies	Analyses of BC relevant online job vacancies		Desk research on online BC ICT communities and fora	
	European Survey on BC Skills		Analysis of participation in BC related VET training programs	
Expert Validation	Expert Validation		European Survey on BC Skills	
Research Methodology on Labour market and Skills Intelligence				

This approach had led to the three occupational profiles Blockchain Developer, Blockchain Architect, and Blockchain Manager. The Skill Sets in terms of Modules and Learning Outcomes have been specified in CHAISE Deliverable D.5.1.1 Blockchain Learning Outcomes Report.

The Learning Outcomes specified there provided the basis for the derivation of skill and knowledge items in the ESCO database. With priority, existing ESCO skills and knowledge elements have been mapped to CHAISE Learning Outcomes. In case this was not possible, new skills and knowledge items have been proposed. The entire proposal was submitted to the ESCO Office, who had it reviewed by their network of experts. The result is specified in this deliverable, and will be introduced to the ESCO database in the next update cycle (end of 2023).

## 1.4 RESULTS/CONCLUSIONS

The key result of this task is a full set of ESCO Profiles for the following occupational profiles:

- Blockchain Developer: major revision and extension of the already existing ESCO profile.
- Blockchain Architect: major revision and extension of the already existing ESCO profile).
- Blockchain Manager: extension of the existing ICT Project Manager occupational profile.

These results will be fully available in the ESCO database from end 2023, aligned with the update cycles decided by the ESCO Office.

## 1.5 USE OF THIS DOCUMENT

This deliverable is intended for public use.

## 1.6 EQF AND ESCO USE IN THE CHAISE INITIATIVE

### 1.6.1 EQF

The European Qualifications Framework (EQF) was recommended by the European Parliament and the Council on 23 April 2008 and repealed on 22 May 2017 (Council of the European Union, 2017). It is:

- A common European reference framework whose purpose is to make qualifications more readable and understandable across different countries and systems;
- The core of the EQF is its eight reference levels defined in terms of learning outcomes, i.e., knowledge, skills and autonomy-responsibility.

The EQF is an 8-level, learning outcomes-based framework for all types of qualifications that serves as a translation tool between different national qualifications frameworks. This framework helps improve transparency, comparability and portability of people's qualifications and makes it possible to compare qualifications from different countries and institutions.

The EQF covers all types and all levels of qualifications, and the use of learning outcomes makes it clear what a person knows, understands and is able to do. The qualification level increases in accordance to the level of proficiency; level 1 is the lowest and level 8 the highest. Most importantly the EQF is closely linked to national qualifications frameworks, making it possible to provide a comprehensive map of all types and levels of qualifications in Europe; such qualifications are increasingly accessible through qualification databases. The Chaise Blockchain qualification is built around EQF level 5 (see table 1). In the module structure of the CHAISE programme, lectures are

accompanied by an explanatory note on how the teacher can adapt the level from EQF level 5 to EQF level 6.

Table 3 EQF Level 5 (adapted from [Europass](#), 2023)

Level 5 – Learning outcomes		
Knowledge	Skills	Responsibility and autonomy
Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others

### 1.6.2 ESCO

[ESCO](#) is the multilingual classification of *European Skills, Competences, Qualifications and Occupations* (Council of the European Union, 2017). It was launched in July 2017 as a first full version as the result of a stakeholder consultation project in 2010. It describes the occupations and knowledge, skills and competences of all sectors and levels within the European labour market, aiming at closing the gap between the world of work and education and developing a shared and transparent understanding of occupations and skills among member states. This will facilitate the exchange of information between people, stakeholders, public administration, and electronic systems.

ESCO is a European Commission project, run by Directorate General Employment, Social Affairs and Inclusion (DG EMPL). It is available in an online portal and can be consulted free of charge. Its first full version (ESCO v1) was published on the 28th of July 2017. The latest version of the classification can be [downloaded](#) or retrieved through the [ESCO API](#).

ESCO is divided in three interconnected pillars: the occupation, the knowledge, skills and competences (or skills pillar) and lastly, the qualifications. The development of the ESCO qualifications is an ongoing process that is filled in with qualifications from national databases. Every occupation in the occupational pillar is linked to a job profile that in turn includes a description, scope note and definition. The job profiles also list the skills and competences that are relevant for the specific profession.

ESCO is managed by the Directorate General for Employment, Social Affairs and Inclusion, supported by Cedefop and other stakeholders. ESCO makes an explicit distinction between transversal and occupation-specific skills (Cedefop, 2019). In the CHAISE blueprint, ESCO is deployed as a reference point, along with EQF, ECVET and EQAVET.

The core added value comes from its facilitation of the following use cases, essential to the European job market:

1) ESCO is used in online applications and platforms:

ESCO's concepts and the relationships between them can be understood by electronic systems. This allows different systems and platforms to use ESCO to suggest the most relevant jobs to jobseekers on the basis of their skills or the most relevant training to people who want to reskill or upskill.

2) ESCO connects people and jobs:

ESCO contains accurate descriptions of occupations and skills that can be used in both drafting job offers and CVs, facilitating comparability and matching. This will support both employers to find the right people for their vacancies and jobseekers to find the right jobs for their skills.

3) ESCO connects employment to education:

The use of ESCO in job offers, research, big data analyses, etc., helps education and training providers to understand what skills the labour markets need. They can then adapt their curricula accordingly to prepare their students better for tomorrow's labour markets. ESCO also helps potential employers to better understand what students have learned.

4) ESCO connects labour markets and promotes mobility:

ESCO is available in 28 languages, allowing job seekers and employers to better communicate about skills, training and jobs in any chosen European language. Through its use in the EURES portal and in many other online platforms, it helps European public and private employment services to offer their services across borders, languages and electronic systems, so that they can better support people who want to work in another European country.

### 1.6.3 ESCO USE IN LABOUR MARKET ANALYSIS

The European Classification of Skills, Competences and Occupations (ESCO) was used in the planning, implementation and results analysis of skills intelligence gathering activities carried out in WP2, through the following ways.

*A) T2.2: Demarcating the Blockchain labour market*

The Blockchain sector was demarcated from the wider ICT sector using the NACE and ESCO classifications. The first step was to identify which ICT related statistical classification of economic activities (NACE) and occupations (based on ESCO and CEN/CWA 16458-1) are most relevant to Blockchain for each partner country. The primary field of investigation was the 4-digit ESCO classification; namely the sub-categories under “251 - Software and application developers and analysts” and “252 - Database and network professionals”. Results showed that the most relevant ICT occupation to include Blockchain employees is “2512 - Software Developers”. Further to “software developers”, other occupational profiles that have been identified to work on Blockchain use cases and need upskilling are:

- 2513 - Web and Multimedia Developers
- 2519 - Software and Applications Developers and Analysts Not Elsewhere Classified
- 2529 - Database and Network Professionals Not Elsewhere Classified
- 2521 - Database Designers and Administrators
- 2511.13 - ICT System Architect

#### *B) T2.2: Collection of Blockchain relevant job vacancies*

The next step included the collection of Blockchain relevant job vacancies to a) identify the skills mostly valued and sought after by employers, b) explore what educational qualifications and experience are required from Blockchain employees, and c) explore in which sectors there is the highest demand for Blockchain employee. Manual documentation and web-scraping technologies were used to extract online job advertisements from job portals from all partnership countries. The collected Blockchain related jobs were mapped and coded according to the International Standard Classification of Education (ISCED); ESCO v1.

#### *C) T2.3: Identification of current demand for Blockchain skills*

Further to the above, a survey addressed to BC employers and field experts was conducted to gather insights on actual workplace requirements and corresponding skill needs, difficulties to recruit and retain staff and future priorities/tendencies for the sector. The survey investigated/covered the entire spectrum of technical, non-technical and transversal skills required for the 3 most demanded BC profiles. The list of skills included in the survey followed the ESCO taxonomy for skills and competences. Correspondingly, the analysis was realised on this basis, and the results obtained and detailed in the project WP2 deliverables, in terms of skills requirements, are in line with the ESCO taxonomy.

#### 1.6.4 ESCO USE IN MONITORING BLOCKCHAIN SKILLS EVOLUTION

The methodology for forecasting Blockchain demand/supply involves gathering information on Blockchain related jobs and mapping this information to International Standard Classification of Occupations (ISCO) categories. ISCO categories are used in order to apply CEDEFOP occupational forecasts that are presented as ISCO categories. In particular, during the first-year of forecasting activities, custom made web-scraping tool was used to extract online job advertisements from LinkedIn for each EU country. Search criteria were based on the keyword “Blockchain” appearing in the job title and/or the detailed job advertisement. Then, the collected Blockchain jobs were mapped to ISCO categories to derive the proportion of specific occupations that are Blockchain related and apply these proportions to CEDEFOP forecasts to estimate the demand for Blockchain skills in the future. Initially, the 4-digit ISCO occupation classification was considered but subject to data constraints in the forecasting model (specifically from the EU-LFS) a 3-digit ESCO/ISCO mapping was eventually employed. The following ISCO categories contain most of blockchain related jobs and were used to forecast blockchains skills demand:

- (ISCO 251) Software and Applications Developers and Analysts
- (ISCO 133) Information and Communications Technology Services Managers
- (ISCO 252) Database and Network Professionals
- (ISCO 121) Business Services and Administration Managers
- (ISCO 261) Legal Professionals

ESCO classification has introduced the following blockchain related occupations: Blockchain Architect (ESCO 2511.14.1) and Blockchain Developer (ESCO 2512.4.1), also in line with CHAISE results (as depicted below). This information provides alternative information on key blockchain workers. More specifically, ESCO classification defines skills and competencies of these blockchain occupations that are important when trying to understand the needs of the blockchain labour market and anticipating blockchain skills demand in the future. Skills and competencies related to blockchain occupations provides necessary information to address skills mismatch in the blockchain labour market. This ESCO information supplements our analysis and provides more detail for the associated ISCO categories that are used to forecast blockchain skills demand and supply.

### 1.6.5 OVERVIEW OF THE INTEGRATION PROCESS

On 13 April 2022, the CHAISE Project Management Team and WP6 Leader (ECQA) had an introductory meeting with ESCO representatives in order to present project results and discuss the procedure and requirements for the integration of the identified BC occupational profiles in the database. The meeting was held in a very good atmosphere with both parties sharing a mutual interest for each other's work and a strong willingness to synergise. Next, the ESCO Technical Team reviewed the CHAISE research findings, acknowledging their added value and confirming their appropriateness and relevance to be incorporated into the ESCO classification system. In a follow-up meeting held on 16 November 2022, it was agreed that the CHAISE partnership will: a) update/revise the occupational profiles of "Blockchain Developer" (2512.4.1) and "Blockchain Architect" (2511.14.1), already included in the ESCO database following the latest update in 2020-21, and b) create a new occupation profile for the role of "Blockchain Manager", which is currently missing. The above also implies the revision of existing skill concepts as well as the creation of new ones directly linked to the aforementioned occupational profiles/roles.

Operationally, the ESCO Technical Team provided the partnership with detailed instructions (including the ESCO feedback template and ESCO terminological guidelines) to guide the integration process. In early 2023, the CHAISE partnership, led by ECQA, submitted all the necessary input for the update of the 3 identified Blockchain profiles. On 3 May 2023, after reviewing the received input, the ESCO Technical Team informed the CHAISE partnership that 34 proposed skills for the occupational profiles of "Blockchain Developer" and "Blockchain Architect" had been approved and will be integrated into the new version of the classification system, scheduled for release in May 2024. Regarding the "Blockchain Manager" profile, the Technical Team suggested introducing it as an alternative label for the role of "ICT project manager" instead of creating a standalone occupation profile. This suggestion was based on two reasons: a) the limited number of online job ads specifically referencing the role of "Blockchain Manager", and b) the fact that the need for management-related skills pertaining to BC and DLT applications (i.e., mostly focused on the introduction of the BC technology in organizations, and the roll-out of BC use cases in the market) were considered to be broad and applicable across various fields, rather than being confined to the boundaries of the Blockchain domain. The CHAISE Project Management Team and the WP Leader (ECQA) agreed to proceed with such an approach, as it aligns with the Alliance's expectations and objectives. This decision also serves as recognition of the quality of the produced results.

## 2 OCCUPATIONAL PROFILES (SPECIALITIES)

The evidence drawn from skills intelligence gathering activities (WP2) showed the emergence of three new roles/positions in the European Blockchain field: a) **Blockchain Developer**, b) **Blockchain**

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**Architect, and c) Blockchain Manager.** This created the need for the introduction of 3 new occupational profiles directly linked to the Blockchain sector, instead of the one initially planned in the Application Form (i.e., “Blockchain Specialist”). The new occupations will fit to the 4th level of ESCO classification (as reference framework), under 251 – “Software and application developers and analysts” and “252 - Database and network professionals” sub-groups. For each identified profile, a dedicated occupational card will be created, with the aim to be eventually embedded into ESCO and other sectoral classification schemes (e.g., CEN/CWA 16458-1).

## 2.1 BLOCKCHAIN DEVELOPER

### 2.1.1 ESCO DESCRIPTION

According to the ESCO classification system, Blockchain Developers: *“implement or program blockchain-based software systems based on specifications and designs by using programming languages, tools, and blockchain platforms”* (ESCO database, 2023).

Scope:

**blockchain developer**

**Professionals** >  
 Information and communications technology professionals >  
 Software and applications developers and analysts > Software developers > software developer >  
 blockchain developer >

---

**Description**

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**Code**  
 2512.4.1

**Description**  
 Blockchain developers implement or program blockchain-based software systems based on specifications and designs by using programming languages, tools, and blockchain platforms.

Figure 1 ESCO description Blockchain developer (adopted from [ESCO database](#), 2023)

Under skills pillar, the skills and competences related to Blockchain Developer are presented below:

## Skills & Competences

### Essential Skills and Competences

- use software design patterns
- use software libraries
- provide technical documentation
- interpret technical requirements
- debug software
- utilise computer-aided software engineering tools

### Essential Knowledge

- software components libraries
- ICT debugging tools
- principles of distributed ledger technology
- blockchain consensus mechanisms
- decentralized application frameworks
- smart contract
- computer programming
- blockchain openness
- blockchain platforms

### Optional Skills and Competences

- design user interface
- use markup languages
- implement front-end website design
- adapt to changes in technological development plans

### Optional Knowledge

- data analytics
- JavaScript
- Vyper
- ICT encryption
- SaaS (service-oriented modelling)
- cloud technologies
- Scala
- Java (computer programming)
- Solidity
- Angular
- C++
- TypeScript

Figure 2 ESCO skills-set Blockchain developer (adopted from [ESCO database](#), 2023)

## 2.1.2 REVISED SCOPE NOTE AND DEFINITION

CHAISE proposes a major revision of the original Blockchain Developer ESCO definition and skill-set, which had been created based upon a proposal of one of the CHAISE consortium members a few years back. The revised specification is indicated below.

**Job Title:** Blockchain Developer

**Job Overview:** The Blockchain Developer codes the Blockchain applications and takes care of problem solving at the micro level. The job role demands general software development skills with great emphasis on the development skills of Blockchain technology and applications, operational business skills, and all transversal future skills, particularly self-managed work. (2.5.1)

**Minimum entry requirements:** There are no formal entry requirements for candidates undertaking these qualifications. Learners are advised to enter the course with a completed level 4 qualification in an area relevant to the job role or with equivalent professional experience.

**Target groups (including ESCO classification):** (25-) ICT Professionals such as for example (2512) Software Developers, (2513) Web and Multimedia Developers, (2519) Software and Applications

Developers and Analysts Not Elsewhere Classified, (2521) Database Designers and Administrators, (2529) Database and Network Professionals Not Elsewhere Classified.

### 2.1.3 ESSENTIAL ESCO KNOWLEDGE

Concept name	Description	Alternative labels/synonyms
Blockchain application areas	The study of the areas in which blockchain is implemented. Banking and Finance, Businesses (Supply Chain Management, Healthcare, Real Estate, Media, Energy), and Government are some examples of this application areas.	Areas of blockchain application; blockchain application fields;
Blockchain applications	The knowledge of applications where blockchains can provide significant added value. They include applications in Banking and Finance (International Payments, Capital Markets, Trade Finance, Regulatory Finance and Audit, Money Laundering Protection, Insurance, Peer-to-Peer Transactions) and Business (Supply Chain Management, Healthcare, Real Estate, Media, Energy), Government (Identity Management, Voting, Taxes, Non-Profit Agencies, Compliance/Regulatory Oversight).	Blockchain functions;
Blockchain applications security principles	The essential security principles, methods and controls for blockchain applications. Identity and access management, key management, data privacy, secure communication, smart contract security, and transaction endorsement are included as part of these principles.	Blockchain security; security controls for blockchain applications;

Concept name	Description	Alternative labels/synonyms
Blockchain components	The study of essential blockchain components and concepts as peer networks, smart contracts, memberships, events, ledgers, system integration, wallets, and system management.	Blockchain concepts; blockchain;
Blockchain design patterns	Re-usable blockchain solution approaches including non-blocking user interface design, asynchronous API design, secure synchronization, time stamping, enterprise business integration, simple assets, and assets with rules.	Design patterns of blockchain
Blockchain history	Key historical facts and milestones in the blockchain technology as well as the implementations and applications that emerged on top of it.	History of blockchain; blockchain technology history;
Blockchain mining principles	Essential blockchain and cryptocurrency mining types and principles include ASIC mining, GPU mining, CPU mining, Cloud mining, and Mining pools.	Principles of mining in blockchain;
Blockchain terminology	The terms used in blockchain sector which include account, attestation, block, Byzantine fault, coin, consensus, crypto-, decentralized application (DApp), DeFi, digital identity, distributed ledger, encryption, ether, fork, hyperledger, Merkle trie, mining, node, NFT, Proof of Authority, Proof of Stake, Proof of Work,	Blockchain terms; terminology of blockchain

Concept name	Description	Alternative labels/synonyms
	public/private blockchain, trustless, validity proof, 51% attack, etc.	
Blockchain-based business models	The study of diverse blockchain business models such as Blockchain-Based Software Products, Blockchain Development Platforms, Token Economy-Utility Token Business Model, P2P Blockchain Business Model, as well as Blockchain as a Service Business Model (BaaS).	Models for blockchain-based business;
Blockchain-based services regulation	Key legal regulations around the blockchain, both existing and emerging ones. In Europe, regulations around the Digital Euro and Crypt-Assets, as well as the Pan-European blockchain regulatory sandbox are considered most essential.	Regulatory framework for blockchain; legal regulations for blockchain; legal guidance for blockchain;
Decentralised identifiers	The knowledge of decentralised identifiers (DIDs). DIDs enable verifiable and decentralised digital identity related to different subjects determined by the controllers of these decentralised identifiers (e.g. an organisation, individual person, data model, abstract entity).	DiDs

Concept name	Description	Alternative labels/synonyms
Digital identity management	The process of providing, managing, auditing and securing digital identities to facilitate and enable approved, authentic requests or connections to view company data, services, systems, networks, and assets.	IAM; digital identity methods;
distributed ledger technologies consensus protocols	The knowledge of essential blockchain consensus protocols including Proof-of-Work (PoW), Proof-of-Stake (PoS), Delegated Proof-of-Stake (DPoS), Practical Byzantine Fault Tolerance (pBFT).	consensus protocols of distributed ledger technologies;
Distributed ledger technologies vulnerabilities	The knowledge of the essential distributed ledger vulnerabilities including exchange hack, 51% attack, exit scam, extortion, DeFi, phishing, and conclusion.	Security in distributed ledger technology;
Game theory	The study of mathematical models of strategic decisions among stakeholders. It has applications in all fields of social science, as well as in systems science, computer science and logic. Essential concepts are the Nash Equilibrium and the Prisoner's Dilemma.	Conflict resolution theory; rational choice theory; interactive decision theory; game theory for blockchain
Smart contract programming languages	Essential Smart Contract programming languages include Solidity, Rust, JavaScript, Vyper and Yul.	programming languages for smart contract;

## 2.1.4 ESSENTIAL ESCO SKILLS

Concept name	Description	Alternative labels/synonyms
Analyse decentralised applications	Analyse decentralized applications for their specific performance requirements in terms of key functions and properties such as identify management, access control, data security, transparency, performance, scalability, and maintainability.	Analyse dApps;
Design process for blockchain-based systems	Design processes for blockchain-based systems which involves the clear identification of problems to be solved through blockchain, specifying the business requirements, identifying a consensus mechanism, choosing the most suitable blockchain platform, designing the blockchain nodes, planning the blockchain configuration, building blockchain APIs, designing user interfaces, and integrating accelerators for optimization.	Design of a blockchain-based system; design process for blockchain application architecture; design process for blockchain technology;
develop blockchain innovative architectures	Develop new blockchain architectures that address properties and priorities as they are needed by specific applications. Argue the advantages and shortcomings of such new architectures with respect to existing ones.	build innovative blockchain architectures;
Evaluate blockchain architectures	Evaluate blockchain architectures with respect to their suitability for specific applications, given the specific importance and priorities of architecture properties for these applications.	Evaluate blockchain applications infrastructure;
Explain blockchain implications	Explain the consequences, impact, and implications of using blockchain technology on the business processes they drive, as well as on a larger scale, also including social and ecological aspects.	Explain practical implications of blockchain; analyse the implications of blockchain for governance;

Concept name	Description	Alternative labels/synonyms
Explain distributed ledger technologies principles	Explain the principles of the system architecture underlying distributed ledger technologies (DLT), in particular blockchain. Understand the DLT system architecture in terms of functional components in the core and service layers, the application service platform, DLT services, and external services. Understand the interaction of these components to provide DLT-based functions such as consensus mechanism functions, ledger management functions, smart contract mechanism functions, and distributed application management functions.	Explain distributed ledger technologies properties;
Identify blockchain innovation opportunities	Identify blockchain innovation opportunities through the introduction of blockchain-based solutions, within a particular sector, but also across sectors. Understand the consequences of essential blockchain properties such as transparency and security for driving forward innovations.	Use blockchain to drive innovation; analyse blockchain-based business innovation;
Implement smart contracts	Implement smart contracts for various applications, and in the most important smart contract frameworks such as Bitcoin and Ethereum, and in the most suitable programming languages such as Solidity, Rust, JavaScript, Vyper and Yul.	Apply smart contracts;
Outline blockchain-based identity management	Outline blockchain-based identity management and access control in terms of how they work, what their benefits are compared to current solutions, and how they can be applied for specific applications.	explain blockchain-based identity management system;



Concept name	Description	Alternative labels/synonyms
Recognise blockchain application areas	Recognise opportunities for the introduction of blockchain-based solutions in various application domains (e.g., supplychains, product-service systems, finances, etc.), as well as their transformative potential in the concerned application area in terms of people's skills, roles they need to fulfill, and processes these roles contribute to. Identify the added value blockchain-based solutions would bring with respect to traditional solutions.	Identify blockchain technology application domains; detect blockchain technology application domains;
Recognise blockchain risks	Recognise risks associated with blockchain and cryptocurrency. Apart from standard risks associated with the business processes they are driving, blockchains bear value-transfer risks linked to the peer-to-peer type of value transfer. Risk are also linked to smart contracts as digital representations of more or less complex business relationships.	Identify risks in blockchain technology; predict risks in blockchain technology;

## 2.1.5 SKILLS REQUIREMENTS AND WORKPLACE TASKS

CHAISE research on skills mismatches (CHAISE D2.5.1, 2021) identified a large diversity in terms of Blockchain strategy and regulation maturity across Europe. By conducting a topography of Blockchain occupations and job profiles in EU countries, the study gathers the characteristics of the Blockchain professional profiles in terms of skills needed in the working environment. Table 3 describes the skills of Blockchain developer.

Table 4 Workplace requirements adapted from CHAISE D2.5.1, 2021

Technical & Blockchain specific Skills	Professional / Business Skills	Transversal Future Skills
<ul style="list-style-type: none"> <li>Coding (C++, Java, Python)</li> </ul>	<ul style="list-style-type: none"> <li>Product Development skills</li> </ul>	<ul style="list-style-type: none"> <li>Self-efficacy &amp; Self-confidence</li> </ul>

<ul style="list-style-type: none"> <li>• Cryptography Development</li> <li>• Smart Contract Development</li> <li>• Distributed Network Engineering skills</li> <li>• Frontend &amp; Backend Development</li> <li>• Development of decentralised Apps.</li> <li>• Maths and Stats</li> <li>• Protocol Engineering</li> <li>• Blockchain Solution Design</li> </ul>	<ul style="list-style-type: none"> <li>• Product Management skills</li> <li>• Skills in Legal &amp; Compliance matters</li> <li>• Finance and Controlling skills</li> <li>• Human Resources Development skills</li> <li>• Customer Success Design</li> <li>• Affiliate Marketing</li> <li>• Marketing skills</li> </ul>	<ul style="list-style-type: none"> <li>• Self-determination &amp; Autonomy</li> <li>• Self-management / organization / regulation &amp; Self-responsibility</li> <li>• Cooperation Competence</li> <li>• Communication Competence</li> <li>• Decision-making Competence &amp; taking Responsibility</li> <li>• Initiative and Performance competence</li> <li>• Ambiguity competence</li> <li>• Design Thinking competence</li> <li>• Innovation &amp; Creativity competence</li> <li>• Future orientation &amp; Willingness to Change</li> </ul>
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The daily routine of Blockchain developers, as identified in CHAISE Registry (2021) of Blockchain online job vacancies, includes:

Table 5 Daily routine of BC developer

Daily routine of BC Developer Professionals
<ul style="list-style-type: none"> <li>• Develop and improve blockchain algorithms (coding)</li> <li>• Define core protocols of a blockchain ecosystem</li> <li>• Develop clients</li> <li>• Write smart contracts</li> <li>• Experiment with consensus mechanisms</li> <li>• Debug software</li> <li>• Interpret technical requirements</li> <li>• Provide technical documentation</li> <li>• Use software design patterns</li> <li>• Use software libraries</li> <li>• Utilise computer-aided software engineering tools</li> </ul>

## 2.1.6 EMPLOYMENT OPPORTUNITIES

Currently, there are only a few market data explicitly related to blockchain profiles (CHAISE D.2.2.1 report, 2021). The following list has been derived from a study on “Job vacancies characteristics” (CHAISE D.2.2.1, 2021, chapter 5.2).

- ICT sector (information technology & services; computer software; internet, telecommunications)
- Financial sector (financial services; banking industry)
- Management consulting
- Higher education
- Research industry
- Marketing and advertising

Blockchain skills are often embedded within the following job profiles:

- Software Engineer
- Full Stack Engineer
- Java Software Engineer
- Back End Developer

## 2.1.7 PROFICIENCY LEVELS AND CERTIFICATE TYPES OFFERED BY CHAISE

In compliance with the CHAISE Validation Methodology (CHAISE D.5.4, 2023), and in order to get qualified and certified for different level of proficiency, Blockchain Developers can pursue the following different certification paths:

- 1) Theory micro-certificates (badges) per CHAISE Skill Card Module (CHAISE D.6.3, 2023):
  - a. no prior experience required and
  - b. course material study with integrated (in general, automated) competence evaluation and
  - c. exam through a certifying organisation (ECQA).
- 2) Practical micro-certificates (badges) per CHAISE Skill Card Module:
  - a. elaboration of at least one practical example and one practical case study or
  - b. evidence of prior practical experience.
- 3) ECQA Summary Certificate summarizing all achievements 1) and 2).

## 2.2 BLOCKCHAIN ARCHITECT

### 2.2.1 ESCO DESCRIPTION

According to the ESCO classification system, Blockchain Architects: *“are ICT system architects that are specialised in blockchain-based solutions. They design architecture, components, modules, interfaces, and data for a decentralised system to meet specified requirements.”* (ESCO database, 2023).

**blockchain architect**

Professionals >  
 Information and communications technology professionals >  
 Software and applications developers and analysts > Systems analysts > ICT system architect >  
 blockchain architect >

**Description**

**Code**

2511.14.1

**Description**

Blockchain architects are ICT system architects that are specialized in blockchain-based solutions. They design architecture, components, modules, interfaces, and data for a decentralized system to meet specified requirements.

**Scope note**

Excludes the development of decentralized systems.

Figure 3 ESCO description Blockchain architect (adopted from [ESCO database](#), 2023)

Under skills pillar, the skills and competences related to the Blockchain Architect profile are presented below:

Scope note: Excludes the development of decentralised systems.

## Skills & Competences

### Essential Skills and Competences

- define technical requirements
- interpret technical requirements
- create business process models
- design information system
- define software architecture
- analyse ICT system

### Essential Knowledge

- blockchain openness
- blockchain platforms
- design thinking
- business processes
- systems development life-cycle
- smart contract
- blockchain consensus mechanisms
- principles of distributed ledger technology

### Optional Skills and Competences

- develop software prototype
- design cloud architecture
- debug software

### Optional Knowledge

- data analytics
- cloud technologies
- decentralized application frameworks
- software components libraries
- ICT encryption
- SaaS (service-oriented modelling)
- statistics

Figure 4 ESCO skills-set Blockchain architect (adopted from [ESCO database](#), 2023)

## 2.2.2 REVISED SCOPE NOTE AND DEFINITION

CHAISE proposed a major revision of this original Blockchain Developer ESCO definition and skill-set, which had been created based upon a proposal of one of the CHAISE consortium members a few years back. The revised specification is indicated below.

**Job Title:** Blockchain Architect

**Job Overview:** The Blockchain Architect designs the multi-levelled architecture of a large Blockchain system and software landscape and ensures the coherence of all aspects of a project as an integrated system. Furthermore, the BC Architect assures the overall technical quality of the BC application.

The job role requires a strong micro and macro perspective. It has a strong focus on developing creative projects in product and use case design, including the conception and design of Blockchain solutions. (2.5.1)

**Minimum entry requirements:** There are no formal entry requirements for candidates undertaking these qualifications. Learners are advised to enter the course with a completed level 4 qualification in an area relevant to the job role or with equivalent professional experience.

**Target groups (including ESCO classification):** (25-) ICT Professionals such as for example (2511) ICT System Architects, (2512) Software Developers, (2513) Web and Multimedia Developers, (2514) Applications programmers, (2519) Software and Applications Developers and Analysts Not Elsewhere Classified, (2521) Database Designers and Administrators (2529) Database and Network Professionals Not Elsewhere Classified.

### 2.2.3 ESSENTIAL ESCO KNOWLEDGE

Concept name	Description	Alternative labels/synonyms
Blockchain concept application	The process of transferring essential blockchain and, more generally, distributed ledger concepts to diverse application domains. For this, the domain-specific challenges, solutions, and consequences of introducing peer-to-peer transaction and consensus patterns need to be well understood.	Blockchain technology application;
Blockchain application areas	The study of the areas in which blockchain is implemented. Banking and Finance, Businesses (SupplyChain Management, Healthcare, Real Estate, Media, Energy), and Government are some examples of this application areas.	Areas of blockchain application; blockchain application fields;
Blockchain signature schemes	Essential digital signature schemes include the RSA scheme, the El-Gamal scheme, Hash functions, Birthday Attacks, the Digital Signature Standard.	Digital signature schemes; signature schemes for blockchain
Blockchain applications	The knowledge of applications where blockchains can provide significant added value. They include applications in Banking and Finance (International Payments, Capital Markets, Trade Finance, Regulatory Finance and Audit, Money Laundering Protection, Insurance, Peer-to-Peer Transactions) and Business (SupplyChain Management, Healthcare, Real Estate, Media, Energy), Government (Identity Management, Voting, Taxes, Non-Profit Agencies, Compliance/Regulatory Oversight).	Blockchain functions;

Concept name	Description	Alternative labels/synonyms
Blockchain applications security principles	The essential security principles, methods and controls for blockchain applications. Identity and access management, key management, data privacy, secure communication, smart contract security, and transaction endorsement are included as part of these principles.	Blockchain security; security controls for blockchain applications;
Blockchain components	The study of essential blockchain components and concepts as peer networks, smart contracts, memberships, events, ledgers, system integration, wallets, and system management.	Blockchain concepts; blockchain;
Blockchain design patterns	Re-usable blockchain solution approaches including non-blocking user interface design, asynchronous API design, secure synchronization, time stamping, enterprise business integration, simple assets, and assets with rules.	Design patterns of blockchain
Blockchain history	Key historical facts and milestones in the blockchain technology as well as the implementations and applications that emerged on top of it.	History of blockchain; blockchain technology history;
Blockchain mining principles	Essential blockchain and cryptocurrency mining types and principles include ASIC mining, GPU mining, CPU mining, Cloud mining, and Mining pools.	Principles of mining in blockchain;
Data security principles	The principles of information and data security. They include, among others, confidentiality, integrity, and availability.	Information security principles; data security methods
Blockchain terminology	The terms used in blockchain sector which include account, attestation, block, Byzantine fault, coin, consensus, crypto-, decentralized application (DApp), DeFi, digital identity, distributed ledger, encryption, ether, fork, hyperledger, Merkle trie, mining, node, NFT, Proof of Authority, Proof of Stake, Proof of	Blockchain terms; terminology of blockchain

Concept name	Description	Alternative labels/synonyms
	Work, public/private blockchain, trustless, validity proof, 51% attack, etc.	
Blockchain-based business models	The study of diverse blockchain business models such as Blockchain-Based Software Products, Blockchain Development Platforms, Token Economy-Utility Token Business Model, P2P Blockchain Business Model, as well as Blockchain as a Service Business Model (BaaS).	Models for blockchain-based business;
Blockchain-based services regulation	Key legal regulations around the blockchain, both existing and emerging ones. In Europe, regulations around the Digital Euro and Crypt-Assets, as well as the Pan-European blockchain regulatory sandbox are considered most essential.	Regulatory framework for blockchain; legal regulations for blockchain; legal guidance for blockchain;
Decentralised identifiers	The knowledge of decentralised identifiers (DIDs). DIDs enable verifiable and decentralised digital identity related to different subjects determined by the controllers of these decentralised identifiers (e.g. an organisation, individual person, data model, abstract entity).	DiDs
Digital identity management	The process of providing, managing, auditing and securing digital identities to facilitate and enable approved, authentic requests or connections to view company data, services, systems, networks, and assets.	IAM; digital identity methods;



Concept name	Description	Alternative labels/synonyms
Distributed ledger technologies consensus protocols	The knowledge of essential blockchain consensus protocols including Proof-of-Work (PoW), Proof-of-Stake (PoS), Delegated Proof-of-Stake (DPoS), Practical Byzantine Fault Tolerance (pBFT).	Consensus protocols of distributed ledger technologies;
Distributed ledger technologies vulnerabilities	The knowledge of the essential distributed ledger vulnerabilities including exchange hack, 51% attack, exit scam, extortion, DeFi, phishing, and conclusion.	Security in distributed ledger technology;

## 2.2.4 ESSENTIAL ESCO SKILLS

Concept name	Description	Alternative labels/synonyms
Evaluate blockchain architectures	Evaluate blockchain architectures with respect to their suitability for specific applications, given the specific importance and priorities of architecture properties for these applications.	Evaluate blockchain applications infrastructure;
Explain blockchain implications	Explain the consequences, impact, and implications of using blockchain technology on the business processes they drive, as well as on a larger scale, also including social and ecological aspects.	Explain practical implications of blockchain; analyse the implications of blockchain for governance;
Explain distributed ledger technologies principles	Explain the principles of the system architecture underlying distributed ledger technologies (DLT), in particular blockchain. Understand the DLT system architecture in terms of functional components in the core and service layers, the application service platform, DLT services, and external services. Understand the interaction of these components to provide DLT-based functions such as consensus mechanism functions, ledger management functions, smart contract mechanism functions, and	Explain distributed ledger technologies properties;

Concept name	Description	Alternative labels/synonyms
	distributed application management functions.	
Identify blockchain innovation opportunities	Identify blockchain innovation opportunities through the introduction of blockchain-based solutions, within a particular sector, but also across sectors. Understand the consequences of essential blockchain properties such as transparency and security for driving forward innovations.	Use blockchain to drive innovation; analyse blockchain-based business innovation;
outline blockchain-based identity management	Outline blockchain-based identity management and access control in terms of how they work, what their benefits are compared to current solutions, and how they can be applied for specific applications.	explain blockchain-based identity management system;
Recognise blockchain application areas	Recognise opportunities for the introduction of blockchain-based solutions in various application domains (e.g., supply chains, product-service systems, finances, etc.), as well as their transformative potential in the concerned application area in terms of people's skills, roles they need to fulfill, and processes these roles contribute to. Identify the added value blockchain-based solutions would bring with respect to traditional solutions.	Identify blockchain technology application domains; detect blockchain technology application domains;

Concept name	Description	Alternative labels/synonyms
Integrate blockchain technology	Integrate blockchain technology in new or existing ICT infrastructures, and understand the key challenges and solution approaches to this integration.	Incorporate blockchain technology;
Implement cryptographic constructs	Implement cryptographic constructs such as hash functions, symmetric-key algorithms, and asymmetric-key algorithms, in the context of specific applications.	Develop cryptographic constructs;
Recognise blockchain risks	Recognise risks associated with blockchain and cryptocurrency. Apart from standard risks associated with the business processes they are driving, blockchains bear value-transfer risks linked to the peer-to-peer type of value transfer. Risk are also linked to smart contracts as digital representations of more or less complex business relationships.	Identify risks in blockchain technology; predict risks in blockchain technology;
Analyse blockchain use cases	Analyse blockchain use cases in different sectors against their needs in terms of blockchain technology and architecture. Particularly, key blockchain use cases in Business, Finance and Banking such as International Payments, Peer-to-Peer Transactions, Capital Markets, Trade Finance or Regulatory Finance and Audit.	Evaluate blockchain use cases; investigate blockchain use cases;
Define roadmap for blockchain in applications	Define and follow a roadmap for the introduction of blockchain in a particular application. Identify the key actions and roles required, as well as the essential milestones and deliverables to achieve.	Create a blockchain roadmap in applications;

## 2.2.5 SKILLS REQUIREMENTS AND WORKPLACE TASKS

CHAISE research on skills mismatches (CHAISE D2.5.1, 2021) identified a large diversity in terms of Blockchain strategy and regulation maturity across Europe. By conducting a topography of Blockchain occupations and job profiles in EU countries, the study gathers the characteristics of the Blockchain

35

professional profiles in terms of skills needed in the working environment. Table 5 describes the skills of Blockchain architect.

Table 6 Workplace requirements adapted from CHAISE D2.5.1, 2021

Technical & Blockchain specific Skills	Professional / Business Skills	Transversal Future Skills
<ul style="list-style-type: none"> <li>Blockchain Solution Design</li> <li>Data / Network Security Design</li> <li>Cloud Infrastructure Design</li> </ul> <p>A basic understanding of:</p> <ul style="list-style-type: none"> <li>Cryptography Development</li> <li>Distributed Network Engineering skills</li> <li>Smart Contract Development</li> <li>Development of Decentralised Apps</li> </ul>	<ul style="list-style-type: none"> <li>Business Needs Analysis</li> <li>BC Use Case Development</li> <li>Product Development skills</li> <li>Product Management skills</li> <li>Skills in Legal &amp; Compliance matters</li> </ul>	<ul style="list-style-type: none"> <li>Learning literacy &amp; Metacognitive skills</li> <li>Self-efficacy &amp; Self-confidence</li> <li>Self-determination &amp; Autonomy</li> <li>Decision Competence &amp; Responsibility-taking</li> <li>Design-thinking Competence</li> <li>Innovation &amp; Creativity skills</li> <li>System &amp; Networked Thinking</li> <li>Future Mindset &amp; Willingness to Change</li> <li>Cooperation Competence</li> <li>Communication Competence</li> <li>Ambiguity Competence</li> </ul>

The daily routine of Blockchain architects, as identified in CHAISE Registry (2021) of Blockchain online job vacancies, includes:

Table 7 Daily routine of BC architect

Daily routine of BC Architect Professionals
<ul style="list-style-type: none"> <li>Develop blockchain infrastructures</li> <li>Design architecture, components, modules, interfaces and data for a decentralised system</li> <li>Choose development platform</li> <li>Determine functionalities</li> <li>Develop prototype</li> <li>Add privacy features</li> </ul>

#### Daily routine of BC Architect Professionals

- Improve UX
- Define technical requirements
- Interpret technical requirements
- Create business process models
- Design information systems
- Define software architecture
- Analyse ICT system

### 2.2.6 EMPLOYMENT OPPORTUNITIES

Currently, there is only little market data explicitly related to blockchain profiles (CHAISE D.2.2.1 report, 2021). The following list has been derived from a study on “Job vacancies characteristics” (CHAISE D.2.2.1, 2021, chapter 5.2).

- ICT sector (information technology & services; computer software; internet, telecommunications)
- Financial sector (financial services; banking industry)
- Management consulting
- Higher education
- Research industry
- Marketing and advertising

Blockchain skills are often embedded within the following job profiles:

- Software Engineer
- Full Stack Engineer
- Java Software Engineer
- Back End Developer

### 2.2.7 PROFICIENCY LEVELS AND CERTIFICATE TYPES OFFERED BY CHAISE

In compliance with the CHAISE Validation Methodology (CHAISE D.5.4, 2023), and in order to get qualified and certified for different level of proficiency, Blockchain Architects can pursue the following different certification paths:

- 4) Theory micro-certificates (badges) per CHAISE Skill Card Module (CHAISE D.6.3, 2023):
  - a. no prior experience required and

- b. course material study with integrated (in general, automated) competence evaluation and
  - c. exam through a certifying organisation (ECQA).
- 5) Practical micro-certificates (badges) per CHAISE Skill Card Module:
  - a. elaboration of at least one practical example and one practical case study or
  - b. evidence of prior practical experience.
- 6) ECQA Summary Certificate summarizing all achievements 1) and 2).

## 2.3 BLOCKCHAIN MANAGER

### 2.3.1 ESCO DESCRIPTION

Contrary to the occupational profiles “Blockchain Developer” and “Blockchain Architect”, the “Blockchain Manager” profile did not exist in the ESCO database when the CHAISE project started. In the context of WP6, and based on the outcomes of the previous CHAISE WPs, CHAISE proposed the introduction of this new occupational profile to ESCO. ESCO investigations based on their standard processes and models, revealed *a still very low amount of explicit “Blockchain Manager” online job vacancies*. However, in alignment with the results of CHAISE research, their more specialised investigations revealed significant presence of this occupation in different online documentation (such as expert’s research). These insights led to the common decision to

- 1) introduce the *alternative label* Blockchain Manager in ESCO;
- 2) assign this new alternative label to the existing occupation **ICT Project Manager**;
- 3) link the blockchain-related skills that CHAISE has assigned to the Blockchain Manager occupation only, to the existing occupation ICT Project Manager.

According to the ESCO classification system, ICT Project Managers: *“schedule, control and direct the resources, people, funding and facilities to achieve the objectives of ICT projects. They establish budgets and timelines, perform risk analysis and quality management, and complete project closure reports.”* (ESCO database, 2023).

ICT project manager

Download ▾

Managers >

Production and specialised services managers >

Information and communications technology service managers >

Information and communications technology service managers > ICT project manager >

Description

Code

1330.7

Description

ICT project managers schedule, control and direct the resources, people, funding and facilities to achieve the objectives of ICT projects. They establish budgets and timelines, perform risk analysis and quality management, and complete project closure reports.

Alternative Labels

ICT project manager

ICT project managers

IT project manager

IT projects manager

web project manager

web projects manager

Figure 5 ESCO description IT project manager (adopted from [ESCO database](#), 2023)

Under the skills' pillar, the skills and competences related to the Blockchain Architect profile are presented below:

## Skills & Competences

### Essential Skills and Competences

apply conflict management

build business relationships

coach employees

create project specifications

estimate duration of work

identify legal requirements

manage ICT project

manage budgets

manage project changes

manage project information

manage staff

perform project management

perform resource planning

perform risk analysis

provide cost benefit analysis reports

recruit employees

train employees

### Essential Knowledge

ICT project management

ICT project management methodologies

internal risk management policy

quality standards

Figure 6: ESCO essential skills-set ICT Project manager (adopted from [ESCO database](#), 2023)

## Optional Skills and Competences

apply change management	apply organisational techniques	carry out project activities
create solutions to problems	define technical requirements	
develop information standards	draft project documentation	execute ICT audits
implement ICT risk management	maintain a central project repository	
maintain relationship with suppliers	manage localisation	organise project meetings
perform procurement processes	provide technical documentation	
use ICT ticketing system	use e-procurement	

## Optional Knowledge

Agile development	Agile project management	DevOps	ICT process quality models
ICT system user requirements	Incremental development	Iterative development	
Lean project management	Open source model	Outsourcing model	
Process-based management	Prototyping development	Rapid application development	
SaaS (service-oriented modelling)	Spiral development	Waterfall development	
crowdsourcing strategy	document management	hybrid model	insourcing strategy
legal requirements of ICT products	object-oriented modelling	outsourcing strategy	
project configuration management	quality assurance methodologies		
service-oriented modelling	software architecture models	software design methodologies	
systems development life-cycle			

Figure 7: ESCO optional skills-set ICT Project manager (adopted from [ESCO database](#), 2023)

## 2.3.2 REVISED SCOPE NOTE AND DEFINITION

**Job Title:** Blockchain Manager

**Job Overview:** The Blockchain Manager leads groups of developers and architects. The Blockchain Manager tracks the implementation progress and maintains close cooperation with business managers or marketing professionals to identify the market requirements for new Blockchain systems and applications. This role is responsible for monitoring the quality of process to ensure that products meet their technical and business objectives, including the ethical reflection of possible areas of application of the technology. It features communication with other stakeholders, such as department managers and marketing professionals.



**Minimum entry requirements:** There are no formal entry requirements for candidates undertaking these qualifications. Learners are advised to enter the course with a completed level 4 qualification in an area relevant to the job role or with equivalent professional experience.

**Target groups (including ESCO classification):** (24-) Business and Administration Professionals such as for example (2412) Financial and Investment Advisers, (2413) Financial Analysts, (2421) Management and Organisation Analysts, (2434) ICT Sales Professionals.

### 2.3.3 SKILLS REQUIREMENTS AND WORKPLACE TASKS

CHAISE research on skills mismatches (CHAISE D2.5.1, 2021) identified a large diversity in terms of Blockchain strategy and regulation maturity across Europe. By conducting a topography of Blockchain occupations and job profiles in EU countries, the study gathers the characteristics of the Blockchain professional profiles in terms of skills needed in the working environment. Table 7 describes the skills of Blockchain manager.

Table 8 Workplace requirements adapted from CHAISE D2.5.1, 2021

Technical & Blockchain specific Skills	Professional / Business Skills	Transversal Future Skills
General technical understanding of <ul style="list-style-type: none"> <li>Blockchain Solution Design</li> <li>Data Analysis</li> <li>Protocol Engineering</li> <li>Smart Contract Development</li> <li>Development of Decentralised Apps</li> <li>Maths &amp; Stats</li> </ul>	<ul style="list-style-type: none"> <li>Business (Needs) Analysis</li> <li>Business Development Skills</li> <li>Product Development Skills</li> <li>Product Management Skills</li> <li>Finance and Controlling Skills</li> <li>Human Resources Development Skills</li> <li>Customer Success Design</li> <li>Affiliate Marketing</li> <li>Marketing Skills</li> <li>BC Use Case Development</li> </ul>	<ul style="list-style-type: none"> <li>Self-efficacy &amp; Self-confidence</li> <li>Self-management/ organization / regulation &amp; Self-responsibility</li> <li>Decision Competence &amp; Responsibility-taking</li> <li>Initiative and performance competence</li> <li>Ambiguity Competence</li> <li>Ethics &amp; Environmental competence</li> <li>Innovation &amp; Creativity skills</li> <li>Sensemaking</li> <li>Future Mindset &amp; Willingness to Change</li> <li>Cooperation Competence</li> </ul>

Technical & Blockchain specific Skills	Professional / Business Skills	Transversal Future Skills
	<ul style="list-style-type: none"> <li>Skills in Legal &amp; Compliance matters</li> </ul>	<ul style="list-style-type: none"> <li>Communication Competence</li> </ul>

The daily routine of Blockchain managers, as identified in CHAISE Registry (2021) of Blockchain online job vacancies, includes:

Table 9 Daily routine of BC manager

Daily routine of BC Managing Professionals
<ul style="list-style-type: none"> <li>Develop blockchain implementation strategies, vision and goals</li> <li>Collaboration and communication with customers, developers and system architects</li> <li>Work with project and product management tools</li> <li>Lead business analyses</li> <li>Monitor human resources, finance and controlling</li> <li>Conduct sales and marketing (analyses)</li> </ul>

## 2.3.4 EMPLOYMENT OPPORTUNITIES

Currently, there are only a few market data explicitly related to blockchain profiles (CHAISE D.2.2.1 report, 2021). The following list has been derived from a study on “Job vacancies characteristics” (CHAISE D.2.2.1, 2021, chapter 5.2).

- ICT sector (information technology & services; computer software; internet, telecommunications)
- Financial sector (financial services; banking industry)
- Sales
- Marketing and advertising
- Management
- Management consulting
- Research
- Research industry

## 2.3.5 PROFICIENCY LEVELS AND CERTIFICATE TYPES OFFERED BY CHAISE

In compliance with the CHAISE Validation Methodology (CHAISE D.5.4, 2023), and in order to get qualified and certified for different level of proficiency, Blockchain Managers can pursue the following different certification paths:

- 7) Theory micro-certificates (badges) per CHAISE Skill Card Module (CHAISE D.6.3, 2023):
  - a. no prior experience required and
  - b. course material study with integrated (in general, automated) competence evaluation and
  - c. exam through a certifying organisation (ECQA).
- 8) Practical micro-certificates (badges) per CHAISE Skill Card Module:
  - a. elaboration of at least one practical example and one practical case study or
  - b. evidence of prior practical experience.
- 9) ECQA Summary Certificate summarizing all achievements 1) and 2).

### 3 REVISED BLOCKCHAIN CONCEPTS AND KNOWLEDGE/SKILLS SPECIFICATIONS IN ESCO

The table below specifies the knowledge and skill concepts that CHAISE has proposed to ESCO, in the very form that the latter provided them back to the consortium after expert reviews and amendments. They will be accessible in this form from the next ESCO database update cycle at the end of 2023. This table's columns have the following meanings:

Column Title	Specification
Concept name	The name of the newly introduce knowledge/skill concept
Description	Short description of this concept
Alternative labels/synonyms	Alternative labels/synonyms in the ESCO database
Skill type	The concept specifies a knowledge or skill element
Skills reusability level	Sector-specific skill or cross-sector skill
Essential skill of	Occupational profile that needs to have the skill
Optional skill of	Occupational profiles that might need to have the skill ( <i>not used</i> )
Broader/narrower skills	Higher-level skill cluster(s)
Hierarchy	Skill allocation to the ESCO skill hierarchy
Hierarchy URI	Unique Ressource Identifier of the skill in the ESCO database (points to parent in the skill hierarchy at this stage)
Label (Digital/Green)	Relevance of the skill to the green (environmental) or digital EU strategy

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Concept name	Description	Alternative labels/synonyms	Skill type	Skills reusability level	Essential skill of	Optional skill of	Broader/narrower skills	Hierarchy	Hierarchy URI	Label (Digital/Green)
<b>game theory</b>	The study of mathematical models of strategic decisions among stakeholders. It has applications in all fields of social science, as well as in systems science, computer science and logic. Essential concepts are the Nash Equilibrium and the Prisoner's Dilemma.	conflict resolution theory; rational choice theory; interactive decision theory; game theory for blockchain	knowledge	Cross-sector	blockchain developer;		Broader concept: mathematics and statistics	mathematics and statistics	<a href="http://data.europa.eu/esco/iscdf/054">http://data.europa.eu/esco/iscdf/054</a>	N.A.
<b>blockchain concept application</b>	The process of transferring essential blockchain and, more generally, distributed ledger concepts to diverse application domains. For this, the domain-specific challenges, solutions, and consequences of introducing peer-to-	blockchain technology application;	knowledge	Cross-sector	blockchain architect;		Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0612">http://data.europa.eu/esco/iscdf/0612</a>	Digital

	peer transaction and consensus patterns need to be well understood.									
<b>smart contract programming languages</b>	Essential Smart Contract programming languages include Solidity, Rust, JavaScript, Vyper and Yul.	programming languages for smart contract;	knowledge	Sector-specific	blockchain developer;		Broader concept: software and applications development and analysis	software and applications development and analysis	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital
<b>blockchain signature schemes</b>	Essential digital signature schemes include the RSA scheme, the El-Gamal scheme, Hash functions, Birthday Attacks, the Digital Signature Standard.	digital signature schemes; signature schemes for blockchain	knowledge	Sector-specific	blockchain architect;		Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0612">http://data.europa.eu/esco/iscdf/0612</a>	Digital
<b>blockchain mining principles</b>	Essential blockchain and cryptocurrency mining types and principles include ASIC mining, GPU mining, CPU mining, Cloud mining, and Mining pools.	principles of mining in blockchain;	knowledge	Sector-specific	blockchain architect; blockchain developer; ICT project manager		Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0612">http://data.europa.eu/esco/iscdf/0612</a>	Digital
<b>blockchain design patterns</b>	Re-usable blockchain solution approaches including non-blocking user	design patterns of blockchain	knowledge	Sector-specific	blockchain architect; blockchain developer;		Broader concept: software and applications	software and applications development and analysis	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital

	interface design, asynchronous API design, secure synchronization, time stamping, enterprise business integration, simple assets, and assets with rules.					development and analysis			
<b>design process for blockchain-based systems</b>	Design processes for blockchain-based systems which involves the clear identification of problems to be solved through blockchain, specifying the business requirements, identifying a consensus mechanism, choosing the most suitable blockchain platform, designing the blockchain nodes, planning the blockchain configuration, building blockchain APIs, designing user	design of a blockchain-based system; design process for blockchain application architecture; design process for blockchain technology;	skill	Sector-specific	blockchain developer; blockchain architect;	Broader concept: designing ict systems or applications	S 1.11.1 designing ict systems or applications	<a href="http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce">http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce</a>	Digital

	interfaces, and integrating accelerators for optimization.								
<b>decentralised identifiers</b>	The knowledge of decentralised identifiers (DIDs). DIDs enable verifiable and decentralised digital identity related to different subjects determined by the controllers of these decentralised identifiers (e.g. an organisation, individual person, data model, abstract entity).	DiDs	knowledge	Sector-specific	blockchain architect; blockchain developer	Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0612">http://data.europa.eu/esco/iscdf/0612</a>	Digital
<b>digital identity management</b>	The process of providing, managing, auditing and securing digital identities to facilitate and enable approved, authentic requests or connections to view company data, services, systems,	IAM; digital identity methods;	knowledge	Sector-specific	blockchain architect; blockchain developer	Broader concept: database and network design and administration	Under database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0612">http://data.europa.eu/esco/iscdf/0612</a>	Digital

	networks, and assets.								
<b>distributed ledger technologies vulnerabilities</b>	The knowledge of the essential distributed ledger vulnerabilities including exchange hack, 51% attack, exit scam, extortion, DeFi, phishing, and conclusion.	security in distributed ledger technology;	knowledge	Sector-specific	blockchain architect; blockchain developer	Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital
<b>data security principles</b>	The principles of information and data security. They include, among others, confidentiality, integrity, and availability.	information security principles; data security methods	knowledge	Sector-specific	blockchain architect;	Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital
<b>blockchain application areas</b>	The study of the areas in which blockchain is implemented. Banking and Finance, Businesses (Supply Chain Management, Healthcare, Real Estate, Media, Energy), and Government are some examples of	areas of blockchain application; blockchain application fields;	knowledge	Cross-sector	blockchain architect; blockchain developer	Broader concept: software and applications development and analysis	Under software and applications development and analysis	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital



	this application areas.								
<b>blockchain-based business models</b>	The study of diverse blockchain business models such as Blockchain-Based Software Products, Blockchain Development Platforms, Token Economy-Utility Token Business Model, P2P Blockchain Business Model, as well as Blockchain as a Service Business Model (BaaS).	models for blockchain-based business;	knowledge	Sector-specific	blockchain architect; blockchain developer	Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital
<b>blockchain applications security principles</b>	The essential security principles, methods and controls for blockchain applications. Identity and access management, key management, data privacy, secure communication, smart contract security, and transaction	blockchain security; security controls for blockchain applications;	knowledge	Sector-specific	blockchain architect; blockchain developer	Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital

	endorsement are included as part of these principles.								
<b>blockchain terminology</b>	The terms used in blockchain sector which include account, attestation, block, Byzantine fault, coin, consensus, crypto-, decentralized application (DApp), DeFi, digital identity, distributed ledger, encryption, ether, fork, hyperledger, Merkle trie, mining, node, NFT, Proof of Authority, Proof of Stake, Proof of Work, public/private blockchain, trustless, validity proof, 51% attack, etc.	blockchain terms; terminology of blockchain	knowledge	Sector-specific	blockchain architect; blockchain developer	Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital
<b>blockchain-based services regulation</b>	Key legal regulations around the blockchain, both existing and emerging ones. In Europe, regulations around the Digital Euro and Crypt-	regulatory framework for blockchain; legal regulations for blockchain; legal guidance for blockchain;	knowledge	Cross-sector	blockchain architect; blockchain developer	Broader concept: interdisciplinary programmes and qualifications involving information and	inter-disciplinary programmes and qualifications involving information and communication	<a href="http://data.europa.eu/esco/iscdf/0688">http://data.europa.eu/esco/iscdf/0688</a>	Digital

	Assets, as well as the Pan-European blockchain regulatory sandbox are considered most essential.					communication technologies (icts)	technologies (icts)		
<b>blockchain history</b>	Key historical facts and milestones in the blockchain technology as well as the implementations and applications that emerged on top of it.	history of blockchain; blockchain technology history;	knowledge	Sector-specific	blockchain architect; blockchain developer;	Broader concept: inter-disciplinary programmes and qualifications involving information and communication technologies (icts)	inter-disciplinary programmes and qualifications involving information and communication technologies (icts)	<a href="http://data.europa.eu/esco/iscdf/0688">http://data.europa.eu/esco/iscdf/0688</a>	Digital
<b>blockchain applications</b>	The knowledge of applications where blockchains can provide significant added value. They include applications in Banking and Finance (International Payments, Capital Markets, Trade Finance, Regulatory Finance and Audit, Money Laundering Protection,	blockchain functions;	knowledge	Cross-sector	blockchain architect; blockchain developer	Broader concept: computer use	computer use	<a href="http://data.europa.eu/esco/iscdf/0611">http://data.europa.eu/esco/iscdf/0611</a>	Digital

	Insurance, Peer-to-Peer Transactions) and Business (Supply Chain Management, Healthcare, Real Estate, Media, Energy), Government (Identity Management, Voting, Taxes, Non-Profit Agencies, Compliance/Regulatory Oversight).								
<b>blockchain components</b>	The study of essential blockchain components and concepts as peer networks, smart contracts, memberships, events, ledgers, system integration, wallets, and system management.	blockchain concepts; blockchain;	knowledge	Sector-specific	blockchain architect; blockchain developer	Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital
<b>distributed ledger technologies consensus protocols</b>	The knowledge of essential blockchain consensus protocols including Proof-of-Work (PoW), Proof-of-Stake (PoS), Delegated Proof-of-	consensus protocols of distributed ledger technologies;	knowledge	Sector-specific	blockchain architect; blockchain developer	Broader concept: database and network design and administration	database and network design and administration	<a href="http://data.europa.eu/esco/iscdf/0613">http://data.europa.eu/esco/iscdf/0613</a>	Digital

	Stake (DPoS), Practical Byzantine Fault Tolerance (pBFT).								
<b>recognise blockchain application areas</b>	Recognise opportunities for the introduction of blockchain-based solutions in various application domains (e.g., supplychains, product-service systems, finances, etc.), as well as their transformative potential in the concerned application area in terms of people's skills, roles they need to fulfill, and processes these roles contribute to. Identify the added value blockchain-based solutions would bring with respect to traditional solutions.	identify blockchain technology application domains; detect blockchain technology application domains;	skill	Sector-specific	blockchain architect; blockchain developer;	Broader concept: designing ict systems or applications	S1.11.1 designing ict systems or applications	<a href="http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce">http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce</a>	Digital
<b>recognise blockchain risks</b>	Recognise risks associated with blockchain and	identify risks in blockchain technology; predict	skill	Sector-specific	blockchain architect;	Broader concept: performing risk	S 2. 7. 5 performing risk	<a href="http://data.europa.eu/esco/skill/7e15">http://data.europa.eu/esco/skill/7e15</a>	Digital

	cryptocurrency. Apart from standard risks associated with the business processes they are driving, blockchains bear value-transfer risks linked to the peer-to-peer type of value transfer. Risk are also linked to smart contracts as digital representations of more or less complex business relationships.	risks in blockchain technology;			blockchain developer;	analysis and management	analysis and management	3e1d-2b12-43ad-89f3-0cf82ebc4a30	
<b>explain blockchain implications</b>	Explain the consequences, impact, and implications of using blockchain technology on the business processes they drive, as well as on a larger scale, also including social and ecological aspects.	explain practical implications of blockchain; analyse the implications of blockchain for governance;	skill	Sector-specific	blockchain architect; blockchain developer;	Broader concept: information skills	S 2.0.0. information skills	<a href="http://data.europa.eu/esco/skill/cd9c487e-09ad-4b82-854b-118feb01f2ed">http://data.europa.eu/esco/skill/cd9c487e-09ad-4b82-854b-118feb01f2ed</a>	Digital
<b>identify blockchain</b>	Identify blockchain innovation opportunities through	use blockchain to drive innovation; analyse blockchain-	skill	Sector-specific	blockchain architect;	Broader concept:	S.4.1.1. identifying opportunities	<a href="http://data.europa.eu/esco/skill/cbe1">http://data.europa.eu/esco/skill/cbe1</a>	Digital

<b>innovation opportunities</b>	the introduction of blockchain-based solutions, within a particular sector, but also across sectors. Understand the consequences of essential blockchain properties such as transparency and security for driving forward innovations.	based business innovation;			blockchain developer;	identifying opportunities		b24e-00f3-4b17-94e9-1fcd34a11c3e	
<b>outline blockchain-based identity management</b>	Outline blockchain-based identity management and access control in terms of how they work, what their benefits are compared to current solutions, and how they can be applied for specific applications.	explain blockchain-based identity management system;	skill	Cross-sector	blockchain architect; blockchain developer	Broader concept: browsing, searching and filtering digital data	S.5.5.1 browsing, searching and filtering digital data	<a href="http://data.europa.eu/esco/skill/258fea29-09db-4918-8235-0d7d529cd31c">http://data.europa.eu/esco/skill/258fea29-09db-4918-8235-0d7d529cd31c</a>	Digital
<b>explain distributed ledger technologies principles</b>	Explain the principles of the system architecture underlying distributed ledger technologies (DLT), in particular blockchain.	explain distributed ledger technologies properties;	skill	Cross-sector	blockchain architect; blockchain developer	Broader concept: programming computer systems	S.5.1.0 programming computer systems	<a href="http://data.europa.eu/esco/skill/a8c3186b-c791-4d57-8f4f-4d12c7a5c6a7">http://data.europa.eu/esco/skill/a8c3186b-c791-4d57-8f4f-4d12c7a5c6a7</a>	Digital

	Understand the DLT system architecture in terms of functional components in the core and service layers, the application service platform, DLT services, and external services. Understand the interaction of these components to provide DLT-based functions such as consensus mechanism functions, ledger management functions, smart contract mechanism functions, and distributed application management functions.								
<b>evaluate blockchain architectures</b>	Evaluate blockchain architectures with respect to their suitability for specific applications, given the specific	evaluate blockchain applications infrastructure;	skill	Cross-sector	blockchain architect; blockchain developer	Broader concept: designing ict systems or applications	S 1.11.1 designing ict systems or applications	<a href="http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-">http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-</a>	Digital



	importance and priorities of architecture properties for these applications.							c270b482e0ce	
<b>develop blockchain innovative architectures</b>	Develop new blockchain architectures that address properties and priorities as they are needed by specific applications. Argue the advantages and shortcomings of such new architectures with respect to existing ones.	build innovative blockchain architectures;	skill	Cross-sector	blockchain architect; blockchain developer	Broader concept: designing ict systems or applications	S 1.11.1 designing ict systems or applications	<a href="http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce">http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce</a>	Digital
<b>integrate blockchain technology</b>	Integrate blockchain technology in new or existing ICT infrastructures, and understand the key challenges and solution approaches to this integration.	incorporate blockchain technology;	skill	Cross-sector	blockchain architect; ICT project manager	Broader concept: setting up computer systems	S 5.2.1 setting up computer systems	<a href="http://data.europa.eu/esco/skill/f839b1da-78b6-4466-86f4-a5798821ea20">http://data.europa.eu/esco/skill/f839b1da-78b6-4466-86f4-a5798821ea20</a>	Digital
<b>implement cryptographic constructs</b>	Implement cryptographic constructs such as hash functions, symmetric-key algorithms, and	develop cryptographic constructs;	skill	Sector-specific	blockchain architect	Broader concept: setting up computer systems	S 5.2.1 setting up computer systems	<a href="http://data.europa.eu/esco/skill/f839b1da-78b6-4466-86f4-">http://data.europa.eu/esco/skill/f839b1da-78b6-4466-86f4-</a>	Digital

	asymmetric-key algorithms, in the context of specific applications.								a5798821ea20	
<b>analyse decentralised applications</b>	Analyse decentralized applications for their specific performance requirements in terms of key functions and properties such as identify management, access control, data security, transparency, performance, scalability, and maintainability.	analyse dApps;	skill	Cross-sector	blockchain developer		Broader concept: designing ict systems or applications	S 1.11.1 designing ict systems or applications	<a href="http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce">http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce</a>	Digital
<b>implement smart contracts</b>	Implement smart contracts for various applications, and in the most important smart contract frameworks such as Bitcoin and Ethereum, and in the most suitable programming languages such as Solidity, Rust,	apply smart contracts;	skill	Cross-sector	blockchain developer		Broader concept: designing ict systems or applications	S 1.11.1 designing ict systems or applications	<a href="http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce">http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce</a>	Digital

	JavaScript, Vyper and Yul.									
<b>analyse blockchain use cases</b>	Analyse blockchain use cases in different sectors against their needs in terms of blockchain technology and architecture. Particularly, key blockchain use cases in Business, Finance and Banking such as International Payments, Peer-to-Peer Transactions, Capital Markets, Trade Finance or Regulatory Finance and Audit.	evaluate blockchain use cases; investigate blockchain use cases;	skill	Cross-sector	blockchain architect		Broader concept: browsing, searching and filtering digital data	S 5.5.1 browsing, searching and filtering digital data	<a href="http://data.europa.eu/esco/skill/258fea29-09db-4918-8235-0d7d529cd31c">http://data.europa.eu/esco/skill/258fea29-09db-4918-8235-0d7d529cd31c</a>	Digital
<b>define roadmap for blockchain in applications</b>	Define and follow a roadmap for the introduction of blockchain in a particular application. Identify the key actions and roles required, as well as the essential milestones and deliverables to achieve.	create a blockchain roadmap in applications;	skill	Cross-sector	blockchain architect; ICT project manager		Broader concept: designing ict systems or applications	S 1.11.1 designing ict systems or applications	<a href="http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce">http://data.europa.eu/esco/skill/b590d4e5-7c62-4b4a-abc2-c270b482e0ce</a>	Digital

## 4 MAPPING OF CHAISE LEARNING OUTCOMES TO ESCO CLASSIFICATION SYSTEM

The table below specifies the knowledge and skill concepts that CHAISE has proposed to ESCO, in the very form that the latter provided them back to the consortium after expert reviews and amendments. They will be accessible in this form from the next ESCO database update cycle at the end of 2023. This table's columns have the following meanings:

Column Title	Specification
CHAISE LO	CHAISE Learning Outcome
CHAISE OP	CHAISE Occupational Profile
ESCO Skill (existing)	Existing ESCO skill(s) matching the Learning Outcomes
ESCO Skill (new)	New skill(s) matching the Learning Outcomes, proposed for ESCO
CHAISE Knowledge	CHAISE knowledge item
ESCO Knowledge (existing)	Existing ESCO knowledge item(s) matching the Learning Outcomes
ESCO Knowledge (new)	New knowledge item(s) matching the Learning Outcomes, proposed for ESCO

CHAISE LO	CHAISE OP	ESCO Skill (existing)	ESCO Skill (new)	CHAISE Knowledge	ESCO Knowledge (existing)	ESCO Knowledge (new)
LO1.1: Describe the main concepts and components of the Blockchain technology	A, D, M			Key blockchain technology components and application sectors	principles of distributed ledger technology	blockchain concepts and components
LO1.2: Recognize the sectors where the blockchain technology can be applied	A, D, M		recognize blockchain application areas	Main historical facts of the blockchain technology development	blockchain openness	blockchain applications
LO1.3: Recall the main historical facts of the blockchain technology development.	A, D, M				computer history	blockchain history
LO2.1: Describe blockchain-related legal environment in Europe and the World.	A, D, M	ensure products meet regulatory requirements		Blockchain-related legal environment.	legal requirements of ICT products	legal environment of blockchain-based products and services
LO2.2: Explain regulatory framework of blockchain based financial services.	A, D, M			Legal underpins of Blockchain technology and smart contracts.		
LO2.3: Recognize legal and regulatory issues and risks when dealing	A, D, M	manage ICT data architecture, respect data	recognize blockchain and cryptocurrency risks	Legal implications of cryptocurrencies.		

with cryptocurrency and blockchain technology.		protection principles				
LO2.4: Discuss the interest of Blockchain technology to manage consent and data access	A, D, M			Legal status of the decentralized autonomous organizations.	security regulations	
LO2.5: Explain implications of blockchain technology for governments, policy makers, law professionals, regulators and society.	A, D, M		explain implications of blockchain technology and governance	GDPR requirements and consent management	GDPR	
LO2.6: Illustrate the impact of the blockchain governance on policy effectiveness.	A, D, M			Blockchain and public policy, governmental regulations		
				Implications of blockchain technology for society, regulators, policy makers, governments, law professionals.		

LO3.1: Explain main terminology of blockchain and distributed ledger technology	A, D, M	apply ICT terminology		Blockchain terminology, differences between centralized database and distributed ledger.		blockchain terminology
LO3.2: Discuss mechanics of decentralized applications.	A, D, M			Decentralized applications, network performance, smart contracts, public/private/consortium networks.	decentralized application frameworks	
LO3.3: Describe characteristics and components.	A, D, M			Blockchain-based application components (e.g., peer-to-peer network, smart contracts, consensus, etc.)		
LO3.4: Explain security features of the blockchain applications.	A, D, M			Basic principles of the blockchain-based application security		blockchain application security principles

LO4.1: Explain what capabilities of blockchain technology enable innovating existing businesses and processes.	A, D, M	think innovately, seek innovation in current practices	identify innovation opportunities enabled by blockchain technology	Fundamental principles of the blockchain technology suitability for business innovation.	principles of distributed ledger technology	
LO4.2: Describe the fundamental business model of blockchain use cases.	A, D, M			Criteria of blockchain technology to be applicable in the business use cases.	business model	blockchain-based business models
LO4.3: Analyse different implementations of blockchain business use cases.	A, D, M			Different application areas / industries for a meaningful use of blockchain technology		blockchain application areas
LO4.4: Examine when blockchain technology becomes a viable option for a business use case.	A, D, M			Ethical and environmental aspects associated with blockchain.	ethics	
LO5.1: Describe how blockchains may secure data, information, and processes by utilizing the transaction	A, D			Information and data security principles.		Information and data security principles



protection and validation principles of blockchains.						
LO5.2: Recognize security vulnerabilities and emerging security challenges in blockchain-based applications, as well as the security flaws in smart contracts.	A, D			Countermeasures to secure blockchain transactions.		vulnerabilities in distributed ledger technologies
LO5.3: Explain identity management principles and access control models within blockchain-based applications.	A, D		explain blockchain-based identity management and access control	Security challenges and smart contract vulnerabilities.		digital identity management
LO5.4: Describe blockchain based personally identifiable information, self-sovereign identity, and decentralized identifiers (DIDs) to address digital identity problems.	A, D	manage digital identity		Blockchain access control principles, Digital identity management principles.		decentralized identifiers (DiD)

LO6.1: Explain fundamental design and architectural primitives of DLT system architecture, e.g., trust-less, permissionless, asynchronous, sybil protection.	A, D		Explain principles of DLT system architecture	Design process for blockchain systems.		design process for blockchain-based systems
LO6.2: Employ design patterns and reusable proved solutions to explain blockchain system development.	A, D			Blockchain design patterns, e.g., Merkel root for verifiable inclusion, longest chain, BFT for finality.		blockchain design patterns
LO6.3: Compare different consensus protocols.	A, D			Consensus protocols (Proof of Work, Proof of Stake, Proof of Capacity, Byzantine Fault Tolerance, etc.).	blockchain consensus mechanisms	DLT consensus protocols
LO6.4: Evaluate the blockchain architecture solutions to different practical scenarios.	A, D		evaluate blockchain architectures	Infrastructure design, in particular P2P network.		

LO6.5: Further develop existing blockchain architectures and apply them to new contexts in a creative way.	A, D		innovate blockchain architectures			
LO7.1: Describe different blockchain platforms (e.g., Ethereum, Hyperledger, IOTA, Corda, etc.).	M			Blockchain platforms, such as Ethereum, Hyperledger, IOTA, Corda, etc.	blockchain platforms	
LO7.2: Explain blockchain technology ecosystem, underlying basic algorithms and essentials of trust.	M			Principles of transaction, smart contract, and mining principles.	principles of distributed ledger technology	
LO7.3: Describe the workings of a blockchain, its operations/transactions, blocks, smart contracts, and mining principles.	M			Network types and performance.	smart contract	blockchain mining principles

LO7.4: Demonstrate the node creation on the Ethereum blockchain, devise accounts, unlock accounts, mine, transact, transfer Ethers and check balances.	M		integrate blockchain technology			
LO8.1: Explain the role of marketing.	M					
LO8.2: Demonstrate strategies for customer support and service design.	M					
LO8.3: Analyse role of networks and customer relationship management for blockchain technologies.	M					
LO8.4: Illustrate products, prices, promotion, and sales strategies for blockchain technology.	M					

LO8.5: Create awareness for blockchain use among broader audience and communicate the benefits of the technology in an accessible way.	M					
LO9.1: Apply fundamental concepts of hash function, Merkle tree commitment scheme, proof of inclusion.	A			Most used cryptographic primitives in BC	ICT Encryption	
LO9.2: Apply major signature schemes used in the blockchain technologies.	A			Cryptography measures used in transaction management, access control, privacy management.	ICT Encryption	blockchain signature schemes
LO9.3: Employ cryptographic protocols and public key infrastructure for enforcing practical security goals in the blockchain-based applications.	A			Authentication, integrity protection methods.	ICT Encryption	

LO9.4: Apply programming tools to implement cryptographic constructions used in the blockchain-based applications.	A		Implement cryptographic constructs	Combine primitives to create secure protocol components.		
LO10.1: Apply good practices for developing smart contracts and describe the advantage of blockchain technology.	D			Frontend and Backend development.		
LO10.3: Analyse decentralized applications, tokenization, voting, auctions, remote selling and etc.	D		analyze decentralized applications	User experience (UX) design principles.		
LO10.3: Apply smart contract programming language (i.e., syntax and concepts like state variables, storage, functions, visibility, mappings, etc).	D		implement smart contracts	Smart contract design and implementation.		smart contract programming language

LO10.4: Design, develop and deploy a smart contract for blockchain applications.	D		implement smart contracts	Programming languages (e.g., solidity, Rust, JavaScript, etc.)		
LO11.1: Analyse the customer profile, debate different ways to innovate, and map the value proposition of a blockchain use case.	A, M		analyse blockchain use cases	Principles to identify the blockchain application customers.		
LO11.2: Redesign heuristics and model the process flow of the blockchain use case.	A, M			Processes and method to redesign the traditional process flows to the blockchain-based use cases.		
LO11.3: Collect and prioritize requirements for defining a minimal viable product (MVP) for the blockchain use case.	A, M			Product development principles using blockchain applications.		
LO11.4: Manage the roadmap for the blockchain use case.	A, M		introduce blockchain in an application over time			
LO11.5: Transfer existing concepts of	A, M					blockchain concept application

blockchain use cases to new contexts						
LO12.1: Illustrate basic concepts from game theory with a blockchain application for remote purchases.	D, M			Game theory concepts used in blockchain applications.		game theory
LO12.2: Describe and define advanced concepts from game theory.	D, M			Game theory models applied in blockchain-based solutions.		game theory for blockchain
LO12.3: Discuss the theoretic game approach from the fees in a blockchain network.	D, M					
LO12.4: Illustrate the game theory behind proof of stake.	D, M					



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