chaise

blockchain skills for Europe

D6.3.1

Blueprint of a VET qualification on Blockchain and Distributed Ledger Technologies

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

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ABBREVIATIONS

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 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 T6.3 "Development of a blueprint for the establishment of a new qualification for the blockchain specialist occupation" aims at creating a blueprint and roadmap for the establishment of a blockchain specialisation qualification (D6.3.1), linked to the newly developed occupation(s).

1.1 SCOPE AND STRUCTURE OF THE CHAISE BLUEPRINT

Introduced by Skills Agenda for Europe in 2016 and revised in 2020, the purpose of a blueprint is to support Cedefop's Skills Intelligence tool by developing a sector skills strategy, design education and training solutions for new occupations and make use of EU tools such as EQF, ESCO, EQAVET and Europass. Blueprint report at hand adheres to EU-requirements, in alignment with standards at national level. It describes: the three (3) occupational profiles identified by CHAISE consortium (Chapter 2), the programme specifications (Chapter 3), methods of delivery (Chapter 4), certification pathways (Chapter 5), quality assurance methods (Chapter 6), requirements for training providers (Chapter 7), apprenticeship standards (Chapter 8). Annexes include consultation results with qualification bodies (Annex 1), planning steps for future accreditation (Annex 2) and learning outcomes of VET programme in Blockchain (Annex 3).

Target group of the blueprint include qualification and accreditation bodies across Europe, qualification experts, VET providers, VET trainers and curricula designers in ICT field and VET learners. Blueprint at hand is based on research findings of CHAISE consortium, EU qualification framework and does not substitute national authorities or national occupational profiles in the participating countries. The goal of the blueprint is to contribute to the harmonization of occupational requirements and recognition of skills for Blockchain specialists at European Union level by providing a roadmap for the CHAISE occupational profiles: Blockchain Developer, Blockchain Architect and Blockchain Manager.

1.2 CURRENT STATUS AND LIMITATIONS FOR ACCREDITATION

The potential of upscaling the blueprint as a reference point beyond CHAISE project life-cycle requires using common reference points for the qualifications (described in learning outcomes), categorization and structure of the terms and concepts used, accessibility and interoperability of the terms and concepts, as well as scalability of the reference points (Cedefop, 2019).

The challenges for accrediting the occupational profiles in the European Union countries are inter-related to the limits of the common reference points that are deployed in current report. Cedefop's report (2019) points out the limits of ESCO classification in terms of coherence of the profiles, the problematic around using skills inventory, the fact that knowledge items are formulated as nouns whereas at national level are usually formulated as phrases with an action verb or are too broad or too specific in some cases. Another challenge is posed when learners can choose only certain parts of the qualification and their learning outcomes and not the whole curriculum, that can impact the comparability of the qualification in other countries.

Despite the limitations of upscaling the qualifications at national level, the blueprint can serve as a starting point for the Blockchain specialization profiles that can be exploited by European Union countries on their own choice and by identifying the common parts across the different national qualifications' frameworks. Factors that enhance the facilitation of recognizing qualifications include among others the explicit description of learning outcomes (what is covered and what not), the explicit expression of performance level of learning outcomes (knowledge, comprehension, application, analysis, synthesis and evaluation) based on the Bloom's Taxonomy and the weighting of learning outcomes (essential and less essential classification).

1.3 AN OVERVIEW OF VET QUALIFICATIONS SYSTEMS IN THE EU

Vocational education and training operates traditionally in the national context of the EU member states, nevertheless it is developing in accordance to European Union and international requirements. The EU VET policy framework for 2021-2025 aims at further developing and recognizing common qualifications frameworks that in turn lead to stronger cooperation among the participating countries, transparency and facilitation of learners'/staff mobility.

The monitoring of national qualifications frameworks (NQF) is conducted by the main key actors: Cedefop, European Training Foundation (ETF), UNESCO and the UNESCO Institute for Lifelong Learning. Among the key priorities of Cedefop there are the transfer of learning across institutional and

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national borders, the implementation of learning outcomes principle, the development of ESCO terminology and Europass platform.

According to Cedefop report (2020a), the majority of EU countries have endorsed the eight levels of qualifications with some exceptions as for instance Slovenia or Ireland (ten levels).

1.4 THE EU TOOLS

The following reference points or systems were selected as basis for current report:

1.4.1 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 level increases according to the level of proficiency, level 1 is the lowest and 8 the highest level. Most importantly the EQF is closely linked to national qualifications frameworks, this way it can provide a comprehensive map of all types and levels of qualifications in Europe, which are increasingly accessible through qualification databases. The Chaise Blockchain qualification is built around EQF level 5 (see table 1). In the module structure of CHAISE programme, lectures are accompanied by an explanation note on how the teacher can adapt the level from EQF level 5 to EQF level 6.

Table 1 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

1.4.2 ECVET

The European Credit System for Vocational Education and Training (ECVET) (Recommendation of the European Parliament and of the Council of the European Union, 2009b) complements and builds on concepts and principles shared with the European qualifications framework (EQF), Europass and the European quality assurance reference framework for VET (EQARF). The aim of the European Credit system for Vocational Education and Training (ECVET) is to:

- make it easier for people to get validation and recognition of work-related skills and knowledge acquired in different systems and countries – so that they can count towards vocational qualifications;
- make it more attractive to move between different countries and learning environments;
- increase the compatibility between the different vocational education and training (VET) systems in place across Europe, and the qualifications they offer;
- increase the employability of VET graduates and the confidence of employers that each VET qualification requires specific skills and knowledge.

ECVET allows learners to accumulate, transfer and use their learning in units as these units are achieved. This enables building a qualification at learners' own pace from learning outcomes acquired in formal, non-formal and informal contexts, in their own country and abroad. The system is based on units of learning outcomes as part of qualifications that can be assessed and validated.

Qualifications and units can be described using ECVET points. The ECVET Recommendation suggested that 60 points are considered equivalent to the knowledge, skills and competences acquired in a year of formal full-time VET (or its equivalent).

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1.4.3 EQAVET

The European Quality Assurance Reference Framework for Vocational Education and Training (EQAVET) (Recommendation of the European Parliament and of the Council of the European Union, 2009a) is a community of practice where members and national experts:

- Exchange information and experience in open discussions.
- Initiate a process of mutual learning and consensus building for the development of common principles, reference criteria, indicators and tools for quality improvement in VET, and the implementation of the Reference Framework.
- Reach shared results and solutions in the development of guidelines and criteria for quality assurance, embedding a culture of quality improvement and sense of ownership in implementing the Reference Framework across Europe.

This community of practice leads to higher levels of cooperation and synergy within and across EU Member States on quality assurance related issues.

The EQAVET+ indicative descriptors aim to support Member States, as they deem appropriate, when implementing the EQAVET Framework. They can also be applied to school-based provision; apprenticeships, lifelong learning programmes, in-company training, and non-formal and informal learning.

The below indicators can be applicable in the project:

EQAVET Indicators:

- Indicator 1. Relevance of quality assurance systems for VET providers
- Indicator 2. Investment in training of teachers and trainers
- Indicator 3. Participation rate in VET programmes
- Indicator 4. Completion rate in VET programmes
- Indicator 5. Placement rate in VET programmes
- Indicator 6. Utilization of acquired skills at the workplace
- Indicator 7. Unemployment rate
- Indicator 8. Prevalence of vulnerable groups
- Indicator 9. Mechanisms to identify training needs in the labour market
- Indicator 10. Schemes used to promote better access to VET

Table 2 *EQAVET indicators and VET area* (adapted from EQAVET, 2023)

Measures of data	
EQAVET Indicators	**VET area**
Indicators 1,9	Context, Input
Indicator 2	Input, process
Indicator 3	Input, process, output
Indicator 4	Process, output, outcome
Indicator 5,6	Outcome
Indicator 7,8	Context
Indicator 10	Process

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2 OCCUPATIONAL PROFILES (SPECIALITIES) TARGETED

Blockchain and DLT is currently under high demand in the ICT and financial sector and an increasing number of other industries starts to understand and apply the benefit of this technology and look for qualified blockchain talents. The study of Blockchain labour market by CHAISE consortium (CHAISE D2.2.1, 2021) has revealed a shortage of talents in this sector. A blockchain qualification represents a highly valuable expansion of skills for professionals as well as people on the job market.

CHAISE consortium study on skills demand (CHAISE D2.3.1, 2021) has revealed that throughout the EU there is a very high demand for BC labour, but strategies to address this shortage are hard to formulate given the “diverse nature of labour demand” (CHAISE D2.3.1, 2021, p.86). Stakeholders pronounced the need to extend technological skills with business and transversal skills which supports findings in the study on skills mismatches of Blockchain consortium that revealed the need for different skills sets and qualifications. These conclusions have led to three refined profiles, i.e. Blockchain Developer, Blockchain Architect and Blockchain Manager.

2.1 BLOCKCHAIN DEVELOPER

2.1.1 ESCO

ESCO is the multilingual classification of *European Skills, Competences, Qualifications and Occupations* (Council of the European Union, 2017). It that was launched in July 2017 as a first full version as result of a stakeholder consultation project in 2010. It describes the occupations and knowledge, skills and competences of all sectors and levels within 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 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 DG Employment, Social Affairs and Inclusion supported by stakeholders and Cedefop. ESCO makes an explicit distinction between transversal and occupation-specific skills (Cedefop, 2019). In CHAISE blueprint, ESCO is deployed as a reference point, along with EQF, ECVET and EQAVET.

2.1.2 SCOPE NOTE AND DEFINITIONS

Based on CHAISE consortium research:

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 ESCO CLASSIFICATION

According to ESCO classification, 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:

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:

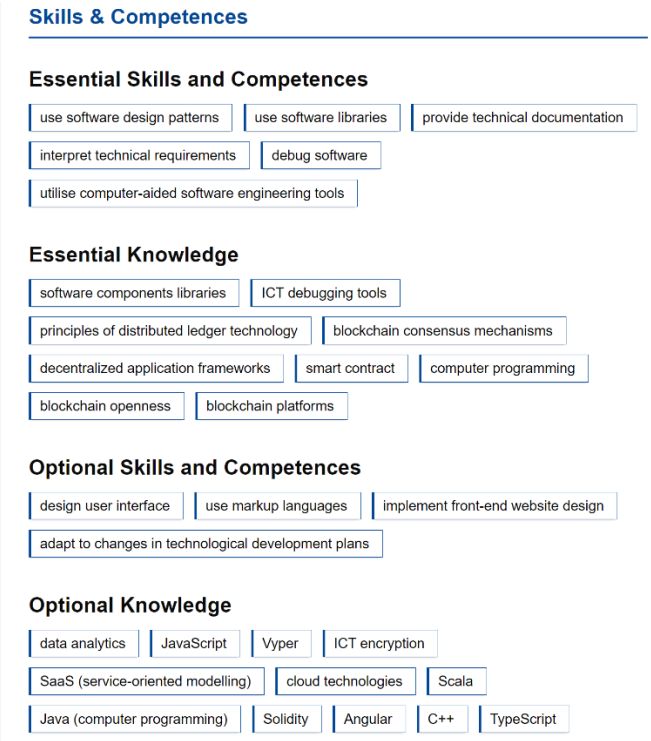

Figure 2 ESCO skills-set Blockchain developer (adopted from ESCO database, 2023)

2.1.4 WORKPLACE REQUIREMENTS

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 3 Workplace requirements adapted from CHAISE D2.5.1, 2021

Technical & Blockchain specific Skills	Professional / Business Skills	Transversal Future Skills
• Coding (C++, Java, Python) • Cryptography Development • Smart Contract Development • Distributed Network Engineering skills • Frontend & Backend Development • Development of decentralised Apps. • Maths and Stats • Protocol Engineering • Blockchain Solution Design	• Product Development skills • Product Management skills • Skills in Legal & Compliance matters • Finance and Controlling skills • Human Resources Development skills • Customer Success Design • Affiliate Marketing • Marketing skills	• Self-efficacy & Self-confidence • Self-determination & Autonomy • Self-management / organization / regulation & Self-responsibility • Cooperation Competence • Communication Competence • Decision-making Competence & taking Responsibility • Initiative and Performance competence • Ambiguity competence • Design Thinking competence • Innovation & Creativity competence • Future orientation & Willingness to Change

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

Table 4 Daily routine of BC developer

Daily routine of BC Developer Professionals
• Develop and improve blockchain algorithms (coding) • Define core protocols of a blockchain ecosystem • Develop clients • Write smart contracts • Experiment with consensus mechanisms • Debug software • Interpret technical requirements • Provide technical documentation • Use software design patterns • Use software libraries • Utilise computer-aided software engineering tools

2.1.5 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

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2.2 BLOCKCHAIN ARCHITECT

2.2.1 SCOPE NOTE AND DEFINITION

Based on CHAISE consortium research:

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.

2.2.2 ESCO CLASSIFICATION

According to ESCO classification, 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).

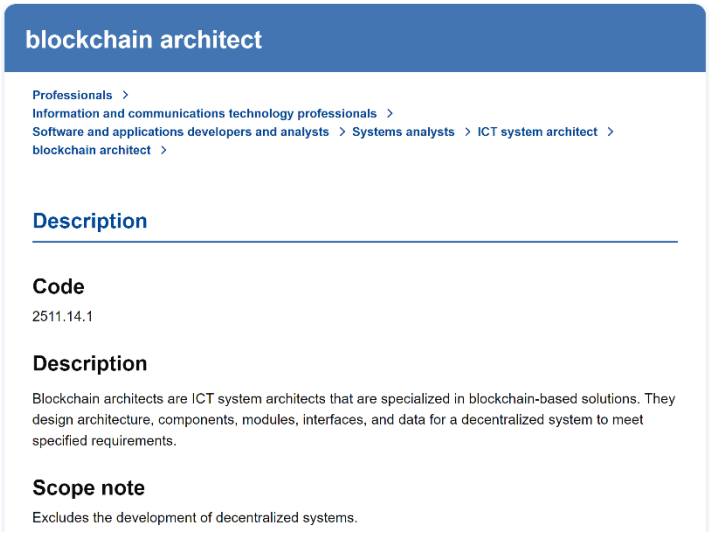

Figure 3 ESCO description Blockchain architect (adopted from ESCO database, 2023)

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

Scope note: Excludes the development of decentralised systems.

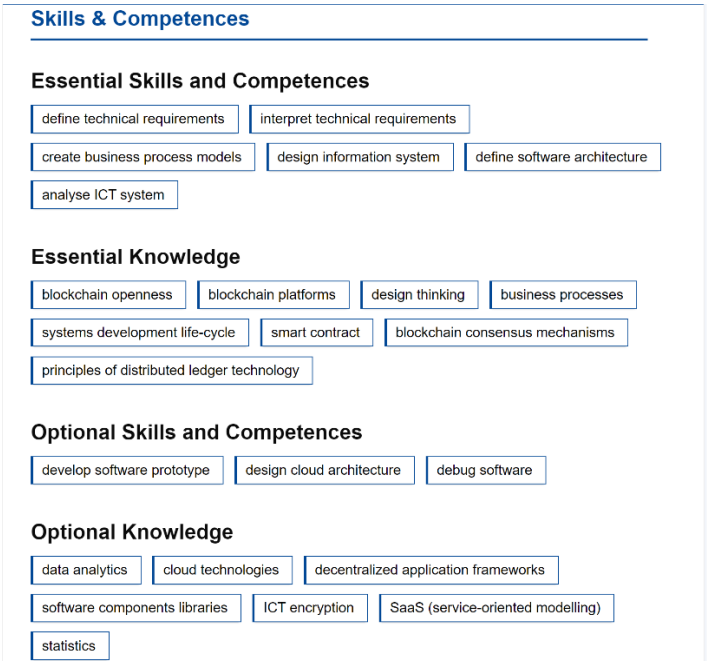

Figure 4 ESCO skills-set Blockchain architect (adopted from ESCO database, 2023)

2.2.3 WORKPLACE REQUIREMENTS

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 5 describes the skills of Blockchain architect.

Table 5 Workplace requirements adapted from CHAISE D2.5.1, 2021

Technical & Blockchain specific Skills	Professional / Business Skills	Transversal Future Skills
• Blockchain Solution Design • Data / Network Security Design • Cloud Infrastructure Design A basic understanding of: • Cryptography Development • Distributed Network Engineering skills • Smart Contract Development • Development of Decentralised Apps	• Business Needs Analysis • BC Use Case Development • Product Development skills • Product Management skills • Skills in Legal & Compliance matters	• Learning literacy & Metacognitive skills • Self-efficacy & Self-confidence • Self-determination & Autonomy • Decision Competence & Responsibility-taking • Design-thinking Competence • Innovation & Creativity skills • System & Networked Thinking • Future Mindset & Willingness to Change • Cooperation Competence • Communication Competence • Ambiguity Competence

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

Table 6 Daily routine of BC architect

Daily routine of BC Architect Professionals
• Develop blockchain infrastructures • Design architecture, components, modules, interfaces and data for a decentralised system • Choose development platform • Determine functionalities • Develop prototype • Add privacy features • Improve UX • Define technical requirements • Interpret technical requirements • Create business process models • Design information systems • Define software architecture • Analyse ICT system

2.2.4 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)
- 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

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2.3 BLOCKCHAIN MANAGER

2.3.1 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 monitors process quality to ensure that products meet their technical and business objectives, including the ethical reflection of possible areas of application of the technology. It features communicating 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.

2.3.2 ESCO CLASSIFICATION

- Not yet listed for Blockchain Manager. CHAISE consortium has applied for a process in ESCO regarding the listing of Blockchain Manager.

2.3.3 WORKPLACE REQUIREMENTS

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 7 Workplace requirements adapted from CHAISE D2.5.1, 2021

Technical & Blockchain specific Skills	Professional / Business Skills	Transversal Future Skills
General technical understanding of • Blockchain Solution Design • Data Analysis • Protocol Engineering • Smart Contract Development • Development of Decentralised Apps • Maths & Stats	• Business (Needs) Analysis • Business Development Skills • Product Development Skills • Product Management Skills • Finance and Controlling Skills • Human Resources Development Skills • Customer Success Design • Affiliate Marketing • Marketing Skills • BC Use Case Development • Skills in Legal & Compliance matters	• Self-efficacy & Self-confidence • Self-management / organization / regulation & Self-responsibility • Decision Competence & Responsibility-taking • Initiative and performance competence • Ambiguity Competence • Ethics & Environmental competence • Innovation & Creativity skills • Sensemaking • Future Mindset & Willingness to Change • Cooperation Competence • Communication Competence

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

Table 8 Daily routine of BC manager

Daily routine of BC Managing Professionals
• Develop blockchain implementation strategies, vision and goals
• Collaboration and communication with customers, developers and system architects
• Work with project and product management tools
• Lead business analyses
• Monitor human resources, finance and controlling
• Conduct sales and marketing (analyses)

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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

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3 PROGRAMME SPECIFICATIONS

For the development of an occupational profile, it is important to distinguish between curriculum and training programme. Cedefop (2010, p.19) assumes that the *"term curriculum refers to the design, organisation and planning of learning activities, whereas the term programme refers to the implementation of these activities".*

3.1 PROGRAMME COMPONENTS, DURATION AND EQF LEVEL

The CHAISE curriculum has been designed at EQF level 5 along with methodological and concept advice at each module in order to be easily adapted to EQF level 6.

3.2 PROGRAMME OUTLINE (MODULES & LECTURES)

The modules include:

1. Introduction to Blockchain Technology
2. Regulation, Legal aspects, and Governance of Blockchain Systems
3. Fundamentals of Blockchain and Distributed Ledger Technology
4. Blockchain Business Management and Planning
5. Blockchain Security and Digital Identity
6. Blockchain System Architecture and Consensus Protocols
7. Blockchain Platforms
8. Marketing and Customer Support
9. Applied Cryptography
10. Smart Contracts
11. Developing Use Cases: From Ideas To Service
12. Game Theory In Blockchains

The curriculum structure includes the below lectures within each module:

Table 9 Illustration of lectures per module adapted from CHAISE D5.1.1, 2022

Modules	Lectures per module
1. Introduction to Blockchain Technology	• Introduction to Blockchain Technology • Blockchain History and Future
2. Regulation, Legal aspects, and Governance of Blockchain Systems	• Blockchain basics to set the regulation and governance • context and requirements • Governance and regulation background • Blockchain ecosystem • Regulation strategy • Blockchain governance • Blockchain as a regulation mean for GDPR
3. Fundamentals of Blockchain and Distributed Ledger Technology	• Information and communications systems for decentralised solutions - Part 1 & 2 • Blockchain components and characteristics • Distributed information systems and their information security management principles
4. Blockchain Business Management and Planning	• The Blockchain Sector - An industry overview of Blockchain use cases and applications and scenarios (good practices) • Applied Digital Ethics & Technology Assessment for Blockchain • Fundamentals of business management methods (applied to Blockchain use cases) - Part 1 & 2
5. Blockchain Security and Digital Identity	• Blockchain Honeypots • Smart contract security • Security risks analysis of blockchain-based applications • Identity management and access control models of blockchain-based applications
6. Blockchain System Architecture and Consensus Protocols	• Basics in blockchain system architecture - Part 1 & 2 • Different consensus protocols • DLT examples
7. Blockchain Platforms	• Overview of platform characteristics • Performance and Scaling

Modules	Lectures per module
	• Ethereum platform and ecosystem • Comparison of selected platforms: IOTA, Hyperledger, others
8. Marketing and Customer Support	• Use of Blockchain in Marketing • Marketing for Blockchain (applied to Blockchain use cases) • Marketing and Customer Support - Part 1 & 2
9. Applied Cryptography	• Cryptographic paradigms • Hash concept • Hashes in blockchain • Zero knowledge and blockchain
10. Smart Contracts	• Building simple smart contracts • Interacting with the blockchain through smart contracts • Building more advanced smart contracts • Tokenizing assets with blockchain
11. Developing Use Cases: From Ideas To Service	• Business Model for Blockchain Use Case • Blockchain Use Case Redesign • Blockchain Use Case MVP • Blockchain Use Case Roadmap
12. Game Theory In Blockchains	• Basic remote purchase • Extended remote purchase • Game theory approach for fees • Game theory behind Proof of Stake (PoS)

3.3 LEARNING OUTCOMES

Learning outcomes are statements of what a learner knows, understands and is able to do on completion of a learning process defined in terms of knowledge, skills and competence.

The learning outcomes are defined in terms of:

- **Knowledge:** in the context of EQF, knowledge is described as theoretical and/or factual.
- **Skills:** In the context of EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).

- **Responsibility and autonomy:** In the context of the EQF responsibility and autonomy is described as the ability of the learner to apply knowledge and skills autonomously and with responsibility.

In the CHAISE VET programme, educational modules are described in terms of technical and blockchain specific skills, business skills and transversal skills. The alignment of learning outcomes in relation to the three occupational profiles Blockchain Architect (A), Blockchain Developer (D) and Blockchain Manager (M) is described in table 10.

Table 10 Educational modules for Blockchain Job Profiles (adapted from CHAISE D.5.2.1, 2022)

<table>
<tr><td colspan="4">Transversal Skills (M, A, D)</td></tr>
<tr><td colspan="4">1. Introduction to Blockchain Technology
2. Regulation, Legal Aspects and Governance of Blockchain Systems</td></tr>
<tr><td colspan="2">Technical Basics (D, A, M)</td><td colspan="2">Business Basics (M, A, D)</td></tr>
<tr><td colspan="2">3. Fundamentals of Blockchain and Distributed Ledger Technologies</td><td colspan="2">4. Blockchain Business Management and Planning</td></tr>
<tr><td colspan="2">Technical Blockchain Specialisation (D, A)</td><td colspan="2">Business Blockchain Specialisation (M)</td></tr>
<tr><td colspan="2">5. Blockchain Security and Digital Identity
6. Blockchain System Architecture & Consensus Protocols</td><td colspan="2">7. Blockchain Platforms
8. Marketing and Customer Support</td></tr>
<tr><td>BC Conception & Use Case Development (A)</td><td>BC Engineering & Development (D)</td><td>Strategic Business Management (A, M)</td><td>Operational Business Management (D, M)</td></tr>
<tr><td>9. Applied Cryptography</td><td>10. Smart Contracts and Digital Currency Programming</td><td>11. Developing use cases: From ideas to services</td><td>12. Game Theory in Blockchain</td></tr>
</table>

The learning outcomes are based on CHAISE study on skills mismatches in the European Blockchain sector (D2.5.1) and Bloom taxonomy focusing on the comprehension and application level. More specifically, to gain the required professional skills:

1. The **Blockchain architect** should learn (3), (5), (6), (9). To acquire business skills, Blockchain architect should study (4), (11). Transversal skills are included in (1) and (2).
2. The **Blockchain developer** should learn (3), (5), (6), (10). To acquire business skills, Blockchain developer should study (4), (12). Transversal skills are included in (1) and (2).
3. The **Blockchain manager** should learn (3). To acquire business skills, Blockchain manager should study (4), (7), (8), (11), (12). Transversal skills are included in (1) and (2).

The full description of learning outcomes is presented under Annex 3. The learning outcomes are based on CHAISE D.5.1 “Learning Outcomes report” (2022) which is officially published here (link).

3.4 ENTRY REQUIREMENTS

For enrolling in the MOOC that constitutes the theoretical part of the VET programme, no specific requirements of knowledge or experience are needed for the three targeted profiles.

For completing the practical assessments and case studies, prior knowledge in ICT, distributed systems, databases, information security or cybersecurity are desirable. The experience can be proved by participation in Blockchain projects for a period of two years. The CHAISE Validation Committee is responsible for designing and approving the relevant criteria.

More specifically, based on the three targeted profiles, the below background is desirable:

- **Blockchain Developer:** strong IT and programming background;
- **Blockchain Architect**: IT solution development, linking DLT's to business transformation;
- **Blockchain Manager:** strong networked IT applications, Customer Relationship Management (CRM), Enterprise resource planning (ERP).

In terms of age, no specific age restriction is posed.

3.5 ECVET CREDITS

Definition of a sector-specific VET curriculum structure. 5 Semester duration CV structure with 1,200 teaching hours and 900 hours work-based learning.

3.6 SPECILISATION PATHWAYS

The training programme offers the opportunity of specialization in learner's main profession based on the three profiles as described in chapter 3.3. Each profile is associated with a pathway related to:

- core study skills in the Blockchain field;
- business/managerial skills;
- and transversal skills.

4 PROGRAMME DELIVERY

4.1 PROGRAMME SCHEDULE (ACADEMIC CALENDAR)

Following EU standards, the CHAISE Blockchain VET programme has a 5-semester duration, broken down into 4 semesters of classroom and lab-based learning (up to 1,200 teaching hours) and 1 semester of work-based learning (up to 900 hours) (project proposal).

Learners can be awarded a maximum of 100 ECVET credits.

Proposed semester schedule:

Table 11 Overview programme schedule for Blockchain developer

Blockchain Developer					
Semester	1	2	3	4	5
Module (nr.)	**Introduction to BC Technology (1)** **Regulation, legal aspects (2)**	**Fundamentals of Blockchain (3)** **Blockchain Business Management (4)**	**Security (5)** **Systems Architecture (6)**	**Smart Contracts (10)** **Game Theory (12)**	**Traineeship**
ECVET (hours)	20	20	20	20	20
Total	100				

Table 12 Overview programme schedule for Blockchain architect

Blockchain Architect					
Semester	1	2	3	4	5
Module (nr.)	**Introduction to BC Technology (1)** **Regulation, legal aspects (2)**	**Fundamentals of Blockchain (3)** **Blockchain Business Management (4)**	**Security (5)** **Systems Architecture (6)**	**Applied cryptography (9)** **Developing use cases (11)**	**Traineeship**
ECVET (hours)	20	20	20	20	20
Total	100				

Table 13 Overview programme schedule for Blockchain manager

Blockchain Manager					
Semes-ter	1	2	3	4	5
Module (nr.)	**Introduction to BC Technology (1)** **Regulation, legal aspects (2)**	**Fundamentals of Blockchain (3)** **Blockchain Business Management (4)**	**BC Platforms (7)** **Marketing and customer support (8)**	**Developing use cases (11)** **Game Theory (12)**	**Traineeship**
ECVET (hours)	20	20	20	20	20
Total	100				

The assigned modules per specialization are a suggested consecutive itinerary, but at the same time the modules and separate lectures are independent learning units that can be integrated in other courses of continuous VET environments. This enables trainers and learners (with a particular educational background) to select contents relevant to their training needs and identified skills deficiencies (CHAISE Project Description).

4.2 THEMATIC COVERAGE PER MODULE

The thematic coverage per module is described in the table here below:

Table 14 Thematic coverage per module adapted from CHAISE VET programme

Module	Lecture	Themes
1: Introduction to Blockchain Technology	Lecture 1 – Introduction to Blockchain Technology	• Overview of CHAISE curriculum • Main components of the blockchain technology • Recognizing its application sectors • Key historical facts of blockchain technology development
	Lecture 2 – Blockchain History and Future	• Early days: First Blockchain protocol, Merkle Tree, Gold Bit, P2P network • Blockchain 1.0: Cryptocurrencies • Blockchain 2.0: Smart contracts • Blockchain 3.0: Digital society • Blockchain 4.0: Future trends

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Module	Lecture	Themes
2: Regulation, legal aspects, and governance of Blockchain Systems	Lecture 1 – Blockchain basics to set the regulation and governance context and requirements	• Blockchain-related legal environment • Legal underpins of Blockchain technology and smart contracts. • Blockchain and public policy, governmental regulations • Implications of blockchain technology for society, regulators, policy makers, governments, law professionals.
	Lecture 2 – Governance and regulation background	• Governance versus regulation: Key definitions, Blockchain context • Collaborative distributed organization: Distributed organization, key governance and legal requirements • Transaction based models: Key definitions, Blockchain Agreements
	Lecture 3 – Blockchain ecosystem	• Ecosystem: key concepts and ecosystems characteristics • Blockchain ecosystems: key blockchain characteristics, actors typology • Usage-based blockchain ecosystems: Usage characterization, example of blockchain ecosystems
	Lecture 4 – Blockchain regulation	• Regulation context: Technology regulation, Blockchain regulation challenges • Blockchain key regulation principles: Incentives and key technic regulation, token and Fiat currencies • Virtual assets regulation: Motivation and key risks, FATF-based regulations (MiCA, ToFR)
	Lecture 5 – Blockchain Governance	• Blockchain governance organization: Governance system organization, Blockchain governance requirements • Blockchain governance principles: Key decisions, off-chain vs on-chain governance • Blockchain governance framework
	Lecture 6 – Blockchain and GDPR	• GDPR: Key principles, obligations and rights • GDPR backed blockchain regulation: Blockchain key principles facing GDPR, implementing key GDPR requirements • Blockchain as a GDPR facilitator: Consent management, data usage tracking
3: Fundamentals	Lecture 1 – ICT systems for	• Trends in Digitalization, Big data, AI, extended reality, cybersecurity, mobility

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Module	Lecture	Themes
of Blockchain and DLT	decentralised solutions	• Fundamentals of internet communication: The Internet, IP (addressing principles, public and private addresses), DNS, TCP/IP stack
	Lecture 2 – ICT systems for decentralised solutions	• Internet applications: client-server principle and application layer, URL, HTTP, HTTPS, Resource formats (HTML, JSON), Web APIs, access control • Distributed and decentralised systems: logical overlay networks • IoT: key principles, architecture, communication • Cloud computing and services: Data centers, service models, containers, fog
	Lecture 3 – Components and characteristics	• Blockchain: Components and characteristics • Blockchain based applications (dApps) • Blockchain Usage: e-Cash prediction, Web3 • Blockchain Use Cases and myths About Blockchain
	Lecture 4 - Distributed Information Systems and their Information Security Management Principles	• Information System / Distributed Information System • Blockchain as a Distributed system: Blockchain before Bitcoin, CAP theorem • Security and Cryptography: Proof of work, transaction consensus and validation, Cryptoeconomics • Cryptography role in blockchain: Public-key cryptography, Hashing, Merkle trees, Zero-knowledge proofs
4: Blockchain Business Management and Planning	Lecture 1 – The Blockchain sector - An industry overview	• Cryptocurrencies: Coins and tokens, Bitcoin • Identity Management: Self-sovereign identity (SSI) • Digital Voting: E-Voting principles, blind signatures • Smart Grids: Crowd-system • Smart Cities: Architecture, Supply chain management
	Lecture 2 – Fundamentals of Business Management I	• Mapping stakeholders in a Blockchain business use cases • Products and services maps: Story-map, Value-Stream-Mapping • Blockchain decision models by Graham, Gervais & Wüst, Lewis, Urban
	Lecture 3 – Fundamentals of Business Management II	• Product and Value Proposition Design: Morphological Box, Value Proposition Template • Business Model Canvas & Business Model Environment: Porter's Five Forces Model

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Module	Lecture	Themes
		• Blockchain Business Model
	Lecture 4 – Technology Assessment & Scenario Planning	• Fundamental principles of the blockchain technology suitability for business innovation • Technology assessment methods: Impact analysis, Consistency analysis, Cross-Impact-Analysis, Morphological Analysis • Scenario Planning: Five phases of scenario development, Scenario tunnel, PESTLE analysis,
5: Blockchain Security and Digital Identity	Lecture 1 – Blockchain Honeypots	• Short introduction to cybersecurity and information security (i.e. Cybersecurity in dApps, cyber threat intelligence • Introduction to honeypots • Honeypot placement and scope • Blockchain node honeypots • Blockchain application honeypots (app anatomy, attack vectors) • Smart contract honeypots (detecting and protecting against smart contract honeypots)
	Lecture 2 – Smart contract security	• Specific security considerations of smart contracts (immutability, interaction, processing costs, access control, decentralised governance) • Smart contract weakness classifications • Best practices (battle-tested and reviewed code, multi-tenant access control, testing, bounties • Review of biggest smart contract exploits (DAO, Wormhole, Parity, Ronin sidechain, Poly network
	Lecture 3 – Security Risks Analysis of Blockchain-based Applications	• Security Risk Management (SRM): Domain Model • Blockchain as a Countermeasure solution • Security Risks Analysis • Sybil Attack and Double-Spending
	Lecture 4 – Identity Management and Access Control Models of Blockchain-based Applications	• Identity management principles in traditional and blockchain-based networks • Access control models and privacy concepts in traditional and blockchain-based networks • Personally identifiable information, blockchain-based decentralised identifiers and self-sovereign identity

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Module	Lecture	Themes
6: Blockchain System Architecture & Consensus Protocols	Lecture 1 - Basics in Blockchain System Architecture	• Features and functioning of distributed ledger • Blockchain architecture design and security considerations • Public and private blockchains, permissioned and permissionless • Blockchain Reference model
	Lecture 2 – Basics in Blockchain System Architecture	• Patterns interacting with the external world (Oracle, Reverse Oracle, Legal and smart contract pair) • Data management patterns (On-chain /off-chain data storage, tokenization, state channels) • Security patterns (Multiple authorization, X-Confirmation, Off-Chain secret enabled dynamic authorization) • Contract Structural Patterns (Contract Registry, Data Contract, Embedded Permission, Factory Contract, Incentive Execution) • Decision models for all above patterns
	Lecture 3 – Consensus Protocols	• Evaluation Criteria of Consensus Protocols (Scalability, Decentralization, Security, Cost) • Survey of Consensus Protocols (Proof of Work, Proof of Stake, Delegated Proof of Stake, Proof of Authority, Practical Byzantine Fault Tolerance) • Evaluating Consensus Protocols
	Lecture 4 – DLT Examples	• DLT Examples (Automotive, Agricultural Supply Chain Management, Secure Voting, Cosmos: Internet of Blockchain)
7: Blockchain Platforms	Lecture 1 – Overview of Platform Characteristics	• Introduction to Blockchain Platforms • System design and network architecture • Consortium, governance, licensing • Technology (Block generation, finality, consensus mechanism, execution, ledger storage, transaction fees, oracles, data and account privacy) • dApps • Blockchain scalability trilemma
	Lecture 2 – Performance Scaling	• Introduction to Blockchain Scaling • Layer 1 Performance Scaling (Block size and production frequency, Consensus mechanism, Alternative data structure, Sharding)

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Module	Lecture	Themes
		• Layer 2 Performance Scaling (Side chains, State channels, Plasma chains, Roll-ups) • Future of Blockchain Platform Optimizations (Interoperability)
	Lecture 3 – Overview of the Ethereum Platform	• Key objectives of Ethereum • Characteristics and network features of Ethereum Platform (i.e. Ethereum Virtual Machine) • Blockchain Technology Ecosystem, underlying algorithms and essentials of trust in Ethereum • Ethereum's approach to scaling and interoperability
	Lecture 4 _ Overview of Hyperledger Fabric and Polkadot platforms	• Key objectives of Hyperledger and Polkadot platforms • Characteristics and network features of Hyperledger and Polkadot platforms • Blockchain Technology Ecosystem, underlying algorithms and essentials of trust in Hyperledger and Polkadot platforms
8: Marketing and Customer Support	Lecture 1 – Introduction to Marketing	• Introduction to Marketing • Strategic Marketing Planning (Evaluating Marketing Landscape, Market Segmentation, Persona, Market Environment, SWOT Analysis • Qualitative Added Value Analysis • Marketing Canvas
	Lecture 2 – Ethical Design Framework	• Value of Blockchain • Social Impact use cases • Intentional Design: Blockchain Ethical Design Framework • Designing and implementing the Blockchain
	Lecture 3 – Blockchain and sustainability	• Sustainability and global agreements • Environmental, Social and Governance (ESG) factors of responsible investment practices • Consensus Mechanism • Green Blockchain Decision Framework
	Lecture 4 – Blockchain in Marketing & Online Marketing Management	• Marketing Challenges (Ad-Frauds, Band Safety, End-to-End Transparency) • Blockchain in the Communication and creative industry • Big Data Management • Customer Segmentation Techniques (Classification, Clustering, Regression, Association, Visualization)

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Module	Lecture	Themes
9: Applied Cryptography	Lecture 1 – Basic Cryptography	• Symmetric Cryptography (Vernam's Cipher, OTP) • Security of Block Ciphers • Data Encryption Standard (DES), triple-DES, AES • Public Key Cryptography (PKC) and algorithms
	Lecture 2 – Hash Functions	• Digital signatures with PKC • Hash functions • Searching with a Hash function, Collisions • One-way hash functions (OWHF) • Hash Algorithms (MD5, SHA1, SHA2-family) • Digital Signature Verification with Hashes
	Lecture 3 – Hashes in Blockchain	• Commitments ("sealed envelope") • Remote Tossing Coins Problem • Merkle Tree (Revocation lists, Responders, Identifiers) • Merkle Proof • Application of Hash in Blockchain (Chaining Blocks, PoW, PoW Attacks, Simplified Payment Verification (SPV)
	Lecture 4 – introduction to Zero-Knowledge Proofs	• Completeness, Soundness and Zero-Knowledge in ZK protocols • Types of proofs proven with Zero-Knowledge protocols • Zero-Knowledge for Blockchain • The Schnorr Identification Protocol

4.3 DELIVERY METHODS AND PEDAGOGICAL APPROACHES

Training providers should familiarise themselves with structure, content and assessment requirements of the qualification before designing a course programme. They may design course programmes of study in any way which:

- best meets the needs and capabilities of their candidates,
- satisfies the requirements of the qualifications.

The CHAISE VET curriculum accommodates three different modes of delivery: a) classroom-based, b) blended (classroom and traineeship combined), distance (online learning).

The course material consists of (video) presentations and lecture notes, practical exercises and case studies, which trainers can adapt to their needs in the classroom or in an online learning environment. The material also allows for distance learning with a trainer or as self-study.

Practical exercises and case studies can be delivered in a lab environment and offer learners hands-on practical experience. The materials correspond to the four core learning styles according to VARK model (Visual, Auditory, Reading & Writing and Kinaesthetic) based on Fleming and Mills (1992).

Table 15 Delivery methods and definition (adapted from D3.3.2)

Materials per module	Definition
4 lectures • 20-30 slides per lecture. • 5-6 pages of slide notes per lecture.	Formal talk about a given subject summarised in slides
4 videos: • 1 video per lecture	A taught lecture providing all information needed to understand and apply its contents
4 practical exercises • 1 practical exercise per lecture	A guided practice about a specific lecture topic
4 case studies • 1 case study per lecture	A real scenario to apply lecture contents and practical exercises
20 questions/answers • 5 questions/answers per lecture	A self-appraisal activity where the student can check his or her progress and understanding

Each module description specifies knowledge, skills and capabilities that learners need to acquire. They can inform training plans to be developed for a work-based learning period.

The Massive Open Online Course (MOOC) serves as a wide access method providing learning materials at increased convenience and maximum flexibility for learners in terms of timing and location. Quality criteria for online learning environment can be extracted from Jakob Nielsen Heuristics (Nielsen Norman Group, 2020) in Human Computer Interaction field regarding online systems. These can include the visibility of system status (constantly informing users on what is going on through appropriate feedback), the match between real world and the system (words and concepts understandable to the learner in a natural and logical order), freedom and user control (visible options to exit the system or easy moving to previous state when choosing system function by mistake), flexibility and efficiency of

use (system caters for both experienced and inexperienced users) and aesthetic design (irrelevant or rarely needed information are omitted).

CHAISE consortium has developed recommendations on delivery methods and pedagogical approaches that should be integrated in Blockchain training programme (HE, VET):

Table 16 Educational methods

Modern Educational methods	Additional initiatives
• Flipped classroom • Project-oriented learning • Cooperative learning • Gamification • Design-thinking • Competency-based learning	• E-learning, online platforms • Interdisciplinary degrees • Hackathons • Project calls (Erasmus plus) • Awards • Formal and non-formal talks with professionals

Some specific aspects of successful education and training in the Blockchain sector have been defined by INATBA for CHAISE (2022) in table 17.

Table 17 Aspects of successful education in BC

Important aspects of a successful education and training in the Blockchain sector
• adopt a hybrid approach; • make it as interactive as possible; • focus on practical application dealing with real world problems; • design project assignments for interdisciplinary teams; • courses should be designed to stimulate the entire process of blockchain projects, from order acceptance, planning, design, programming to testing and implementation; • include case studies (successful and not successful); • encourage mindset change – from centralised to distributed/decentralised business model; • encourage self-learning capabilities; • encourage learning by doing/experimenting; • continuous learning (as it is a quickly evolving area).

Cedefop (2023) guidelines in lifelong learning highly recommend the facilitation of group learning. A group can be established in the classroom but also online. Group learning enables learners to share and benefit from the experience, knowledge and skills of their peers. They can get help when questions

arise and measure their understanding of new concepts and skills in a safe environment (ibid). A group setting also serves to train important soft skills, among others self-confidence, cooperation and communication skills.

4.4 ASSESSMENT CRITERIA AND EVALUATION METHODS

Assessment must be carried out according to standards of national training providers and evaluation methods approved by them. The following assessment tools are included in the training material:

Table 18 Assessment tools

Assessment tools	Weight
• 5 Questions/answers per module • Multiple-choice questions • Case studies	• 30% • 30% • 40% (for evaluating autonomy, proactivity, teamwork)

The proposed weights can be adapted by training providers. The evaluation should include aspects such as: autonomy, proactivity in learning, teamwork capacities and other transversal future skills. The final mark for the course will be an average mark of final grades in all modules.

4.5 STUDYING RESOURCES

Training material for each module consists of:

- lectures (including lecture notes and videos),
- practical exercises,
- case study analysis,
- questions and potential answers series.

The training material supports theoretical and practical learning.

Suggested learning resources:

Books:

Arvind Narayanan, et. al. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction. Princeton University Press, 2016. ISBN 978-0691171692.

Antonopoulos, Andreas M. Mastering bitcoin [on line]. 2nd. ed. Beijing: O'reilly Media, 2017 [Consultation: 19/10/2021]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=4875878. ISBN 9781491954362.

Rosenbaum, Kalle. Grokking bitcoin [on line]. Manning Publications, 2019 [Consultation: 19/10/2021]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=6642506. ISBN 9781638355977.

Solorio, Kevin; Kanna, Randall; Hoover, David H. Hands-on smart contract development with solidity and Ethereum: from fundamentals to deployment [on line]. Sebastopol, CA: O'Reilly Media, 2020 [Consultation: 05/07/2021]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=5984595. ISBN 9781492045236.

Videos:

- CHAISE YouTube Channel: https://www.youtube.com/channel/UCyb5LY3gl2kXCtVmWKDqI5Q
- Blockchain visual demo: https://www.youtube.com/watch?v=_160oMzblY8

Websites:

- Speed Run Ethereum: https://speedrunethereum.com/
- The Ethernaut: https://ethernaut.openzeppelin.com/

5 CERTIFICATION PROCEDURE

5.1 CERTIFICATION PATHWAYS FOR LEARNERS

Policy documents in the vocational educational training (Cedefop, 2019) suggest the provision of flexible and modular learning opportunities. CHAISE VET programme provides learners with the occupational skills, as well as with transversal competences allowing flexibility in the pathways that a learner can choose to certify his/her knowledge.

5.1.1 NATIONAL CERTIFICATION PROCEDURES

National certification procedures vary across European countries. We choose as example of VET the case of Germany to describe the typical examination procedure for vocational qualifications. It should be noted that each EU member follows different national certification procedures.

Advanced vocational qualifications in Germany

Germany features advanced vocational qualifications at EQF levels 5 to 7 which are nationally recognised; learners can acquire them through exams and they are considered equivalent to academic qualifications (Cedefop, 2020b):

- (a) professional specialist (Geprüfte Berufsspezialist) (EQF level 5, ISCED level 554);
- (b) bachelor professional: master craftsperson, specialist (EQF level 6, ISCED level 554, 665);
- (c) master professional: management and expert (EQF level 7).

According to these levels, federal training regulations are issued for training qualifications in specific occupational fields. Qualifications can also be defined by competent bodies. The chambers of industry and commerce as well as chambers of skilled crafts are competent bodies and can issue training examination regulations. The district issuing chamber is responsible for implementation, testing and monitoring, the examinations are valid in all of Germany. The application of the Vocational Training Act (BBiG) is monitored by the Federal Institute for Vocational Education and Training (BIBB). To this end BIBB makes recommendations to the competent bodies (Cedefop, 2020b).

5.1.2 ECQA CERTIFICATION

The validation of the defined learning outcomes in terms of knowledge, skills and competences, to be acquired by attending the CHAISE VET programme, is conducted through an online examination that is hosted on the examination portal of the European Certification and Qualification Association (ECQA).

ECQA, certified with ISO 17024, is entitled to issue certificates on the basis of track records of achievements mainly via multiple choice exams and practical exercises. Eligible are the learners that have attended the whole or parts of CHAISE VET programme.

The CHAISE certification scheme distinguishes between three levels of certification for the targeted occupational profiles:

- **A) Theory badge:** is targeting the learners that have completed the MOOC CHAISE VET programme after successfully passing the multiple-choice questions. This badge includes no practical elements and leads to the awarding of the "Theory badge". It is also a pre-requisite to obtain an ECQA certificate (full ECQA certification).
  Learners can take up to 3 MCQ Modules at once.

- **B) Practical badge:** is targeting the learners that have completed the MOOC CHAISE VET programme after successfully passing the multiple-choice questions and the practical exercises. The practical elements are checked by the Validation Committee who awards the "Practical badge". It is also a pre-requisite to obtain an ECQA certificate (full ECQA certification).

- **C) Full ECQA certification:** it refers to the completion of each Blockchain Module and a positive assessment of the respective practical tasks and MC Questions. The Theory and Practical badge lead to the ECQA certificate.

5.2 GRADING SCALE AND PASS REQUIREMENTS

The examination will consist of a) Questions & Answers, b) practical exercises (to act as proof of the acquisition of practical capacities), and c) multiple choice questions, which will be based on specific performance criteria linked to the intended learning outcomes. A different examination procedure with a corresponding pool of assessment material is designed for each of the three occupational profiles that are addressed by the CHAISE VET programme. The examination will be in English and will rely on a wide pool of questions/exercises of the same proficiency level that will be automatically, randomly selected in each exam. The evaluation of practical exercises and working experience evidence will be performed by external experts on a voluntary basis. This need will be served by a Validation Committee during the project duration.

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5.3 LEVEL OF THE CERTIFICATE AND ACCESS TO THE NEXT LEVEL OF EDUCATION

The successful completion of the examination will lead to the award of a certificate (as prescribed above) stamped by ECQA. This certificate will act as an official, recognised testimonial of relevant skills acquisition, to be used as evidence in the labour market. The process is regulated and monitored by a Validation Committee, which is charged, among others, to decide, keep update and renew the examination content, on an annual basis. The examination portal will also keep a record of certified applicants.

5.4 CHAISE CERTIFICATE SUPPLEMENT

The Europass Certificate Supplement is a document that provides information about a vocational qualification, such as an apprenticeship or a training course. It enables employers and VET providers understand the purpose, level, learning outcomes and information on the relevant education system of learners' vocational qualification. Certificate supplements serve as an intermediate level of information between the VET provider and the labour market without overloading the potential employer with much unneeded information (Cedefop, 2022b).

The Blockchain Certificate Supplement is issued by VET providers that either deliver the CHAISE curriculum or have integrated part of CHAISE learning outcomes into their training offerings (as component of a broader ICT training course).

6 QUALITY ASSURANCE METHODS

6.1 ALINGMENT WITH EU QA FRAMEWORK

The backbone of CHAISE training programme is the application of EU quality assurance framework in VET and higher education in relation to EQF, ECVET, EQAVET and ESCO classification. Among the most highlighted factors that ensure the comparison and therefore future uptake of vocational education and training qualifications is the use of learning outcomes. A recent study by Cedefop (2022) revealed that learning outcomes and well-structured concepts in the reference points (i.e. ESCO) and the qualifications descriptions, enable a closer look at the content of qualifications and the comparison with the requirements of the labour market. The study also showcased that the description of skills set of the respective qualification helps the mapping of qualifications at national and EU level. The quality of qualifications is further related to how the achieved outcomes are experienced by the stakeholders and market representatives, accompanied by the perspective of the VET provider.

6.2 QA ASPECTS

Good VET governance requires strong feedback mechanisms between the education providers and the labour market. According to Cedefop (2022), the quality feedback loop as presented in figure 5, shows the importance of perceptions of learning outcomes by teachers, learners, and employers.

After analysing recent Cedefop reports (2019, 2022), the future accreditation of qualification should take into consideration the below aspects that enhance the quality of the qualification:

- Usage of common reference point(s) in terms of EQF, ECVET and ESCO classification;
- Explicit formulation of learning outcomes (what is included and what not, right level of details, and their weighting;
- Clear categorization and structure of terms and concepts used;
- Paying attention at the transferring of the right meaning of concepts when translated at national level (i.e. neutral terminological reference);
- Paying attention to how the qualification might be affected with elective modules possibilities;
- Clarifying specific needs of the targeted groups in Blockchain community;
- Potential of using the reference point(s) for scaling the qualification;
- For stakeholders, information overload should be avoided (light, practical information);

- For employers, certificate supplements provide standardised information and facilitate the recruitment process.

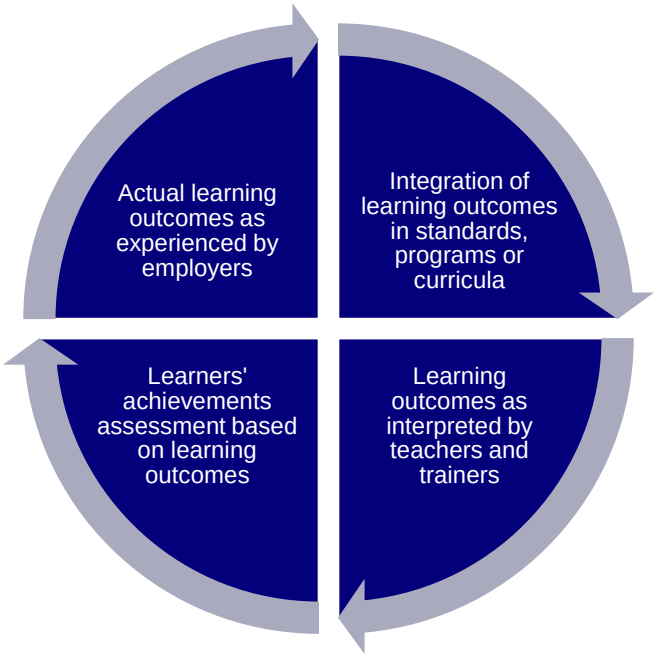

Figure 5 The feedback loop of learning outcomes (adapted from Cedefop, 2021a)

6.3 DATA PROTECTION

Data protection and confidentiality based on the EU General Data Protection Regulation (2016/679, "GDPR") and other specific national data protection regulations, should be taken into consideration when delivering the qualification. Data protection is related to protecting the identity of the individuals, learners, employees and employers taking part in the learning or practicing process (during work-based learning).

Participants should explicitly consent in written on how their data are being stored and used and should have the right to withdraw their consent at any point. Confidential information related to assessment records should also be protected. Lastly, complying with health and safety regulations using IT equipment is the responsibility of the VET provider or the employer for the practical part.

6.4 SOCIETAL IMPACT & ETHICAL CONSIDERATIONS

With the skills and competences acquired in the BC qualification, learners should be able to critically reflect ethical issues related to BC and participate in ethical decision making. Equal opportunities should be provided for all participants, unhampered by artificial barriers, prejudices, or preferences and without discriminating against particular groups and/or gender. White hat coding should also guide the BC learners.

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7 REQUIREMENTS FOR TRAINING PROVIDERS

Every EU country is responsible for the organisation of national VET and the content thereof. At this point, there exist no binding regulations or requirements for training providers on the EU level.

At statutory level, all EU member countries have defined their own mechanisms for internal and external quality assurance among training providers, as well as the job roles they can certify. Germany for example, stipulates those in the Vocational Training Act (BBiG) and the Craft and Trades Regulation Code (HwO). These documents describe training regulations and their development, execution of trainings and the monitoring through the chambers (BIBB, 2017, p. 7). Training providers eligible under those national systems adhering to national standards are deemed suitable for the delivery of the Blockchain curriculum.

A key initiative of European VET policy is the foundation of 'Centres of Vocational Excellence' (CoVEs). CoVEs are a "bottom-up approach to excellence where Vocational Education and Training (VET) institutions rapidly adapt skills provision to societal and economic needs, supporting the green and digital transitions, as well as the post-CoVID recovery" (European Union, 2021). Along with so-called 'Inter-company vocational training centers' (ITC), which is a cooperation of companies working together and sharing their resources and capacity to provide VET, they are set to implement the European Skills Agenda and the Pact for Skills. In Germany, for example, ITCs are usually governed by chambers of crafts and their affiliated organizations.

Training providers awarding micro credentials (e.g. Digital Promise, Udemy, City & Guilds) are of special interest to the CHAISE consortium. The consortium has envisaged to respond to Blockchain skills shortages on the labour market quickly and micro credentials are perceived by many as a suitable tool to address short term business needs (Cedefop, 2022a). They also suit the modular and elective nature of the CHAISE curriculum. Especially in the field of ICT, many businesses already distribute micro credentials to award and certify completion of company trainings (ibid). However, no binding regulations have been stipulated.

General requirements include:

- Training providers need to have in place mechanisms of internal quality assurance and they should also undergo external quality assurance.
- Internal QA should include policies for staffing, continuous development, inclusion and gender equality.
- Key stakeholders need to be represented in the organizational processes.

- Public information about the institution's activities, including programmes should be visible and up-to-date.
- A policy for information management should be in place.

7.1 RESOURCES AND EQUIPMENT

The resources offered for this course and specific in the curriculum structure include:

- Videos
- Lecture notes
- Practical exercises
- Case studies
- Question / answer series
- Multiple Choice series

Equipment that learners need to have access to:

- A personal computer with hardware features to execute the BC practical exercises;
- Internet connection;
- Paper, pencil, board for theoretical activities and computer classroom for BC exercises.

Access to people with disabilities (permanent or temporary) and special educational needs must be ensured during teaching and examination.

7.2 TEACHING STAFF QUALIFICATIONS

EU member states have rules and regulations in place that are used to assess competences and capabilities of teaching staff. Germany for example, works with the Ordinance in Trainer Aptitude (AEVO) to assess who can teach learners in a company setting (BIBB, 2017). Each country will offer different trajectories and training programmes for trainers to get qualified.

More generally, training providers need to ensure that trainers are "personally and professionally suited to their role. Professional aptitude, occupational experience, and pedagogical competence guarantee that trainers are themselves in possession of the skills, knowledges and competences that they need to

impart." (BIBB, 2017, p. 71). It is the task of trainers to plan a training according to training requirements, prepare, conduct and complete the training (ibid).

For the three Blockchain profiles, teachers and trainers must be able to demonstrate that they meet specific occupational expertise requirements related to:

- technical knowledge in the area of Blockchain to the same level as the programme being offered;
- the experience in the Blockchain area is recent and is constantly being updated through continuing professional development;
- development of methods for maintaining contacts with employers, associations, and other educational institutes in the Blockchain filed to ensure that teachers/trainers are updated in terms of legislation, policies, recent developments and codes of practice.
- there is sound experience of providing training.

Furthermore, CHAISE consortium has given some general advice on trainer actions, educational and training approach (CHAISE D4.3.1, 2022, p. 38):

Table 19 Trainer actions

Trainer actions, educational and training approach
• Boost research in this field through international and inter-sectoral project calls. • Strengthen cross-border academia-business collaboration. • Participate on a creation and engage in interdisciplinary degrees. • Observation of experts and projects in the business world. • Follow and engage with professional bodies or pioneers in particular fields. • Organise talks and discussions with professionals. • Introduce ambassador/apprentice (train the trainers) initiatives.

7.3 GENERAL REQUIREMENTS FOR APPROPRIATE TRAINING PROVISION

Some general requirements for appropriate training provision are summarised below:

- Detailed lesson plans clearly referenced to curriculum's modules and lectures must be put in place.

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- All exercises are designed and delivered to meet the curriculum's learning objectives.
- Each module and activity include recommended timings and equipment required.
- Modules begin with a self-assessment tool that allows the trainee to reflect on their current level of skill and competence based on the learning outcomes.
- A scheduled evaluation of trainings and curricula is in place.
- Curricula are updated accordingly.
- There is coordination of all processes regarding admission, progression, recognition and certification of learners.

7.4 HEALTH AND SAFETY RULES

Legal considerations may apply to this qualification, such as Health and Safety using IT equipment and accessibility for all learners. It is the responsibility of centers to ensure compliance with all local, regional and national legislation which may affect delivery of the qualification, and to ensure that candidates are fully aware of any requirements.

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8 APPRENTICESHIP STANDARDS

To increase mobility and opportunities for Blockchain workforce, Work Based Learning (WBL) is an essential component of training delivery. It increases the share of Blockchain companies providing in-house training, as well as the number of Blockchain learners/employees studying or working abroad. According to Cedefop (2015*), "demand for WBL in CVET is strongest in areas with high rates of technological progress"* (p. 28). More generally, WBL should be promoted everywhere and in combination with other forms of adult training, striving to develop both "job-specific skills and broader skills" (Council of the European Union, 2011, p.5).

The EU features a highly diverse landscape of work-based CVET practice, in terms of location (on-the-job, off-the-job), timing (part-time, full-time, after work-hours), origin of trainers (formal or non-formal education and training providers, commercial institutions, in-house trainers) and duration of training (Cedefop, 2015). No binding regulations have been defined on the supra-national level. Important insights can be drawn from the *European Framework for Quality and Effective Apprenticeships* (Council of the European Union, 2018).

8.1 ENTRY REQUIREMENTS AND DURATION

Duration of traineeship for the CHAISE VET programme is set to 20 % of total qualification time and to one semester that should follow four semesters of classroom and lab-based learning or blended / distance learning, respectively.

Depending on sector and company, *"specific requirements for competences that must be ensured among employed persons are in place (such as safety regulations)"* (Cedefop, 2015, p. 34). Parts of the budget for WBL needs to be reserved for this (ibid). Also, eligibility requirements and legal requirements can affect WBL and different governing bodies can regulate trainings and training providers.

Entry should be granted based on relevant formal, informal and non-formal learning or other measures of preparation nationally or from abroad (Council of the European Union, 2018). Qualifications acquired in work-based learning should be part of and referenced to national qualification frameworks and should in turn grant access to higher levels of education and training in VET, HE and WBL (ibid).

8.2 UNITS OF LEARNING OUTCOMES AND INDICATIVE WORK TASKS

Learning outcomes of the CHAISE VET programme have been defined at the level of each module based on three different categories: knowledge, skills, responsibility and autonomy. The units are described in the CHAISE Curriculum Structure (CHAISE D5.2.1, 2022) along with duration, weighting of outcomes, learning methods and assessment criteria. The learning outcomes correspond to EQF level 5, but every module provides methodological and concept advice to easily adapt the contents to EQF level 6.

Indicative work tasks for the period of work-based learning can be derived from the list of attainable learning outcomes.

A period of traineeship should terminate with an institutionalised *"validation of knowledge, skills and competences attained through work-based CVET."* (Cedefop, 2015, p.60). In the German formal CVET context, this validation is carried out by the regional Chambers of Commerce.

Generally, employers, training providers and trade unions (where applicable) should work together to deliver comprehensive learning outcomes, to balance practical and theoretical knowledge, skills, and capabilities. Learning outcomes should be job specific as well as competence oriented to encourage lifelong learning and career opportunities in the setting of a fast changing labour market (Council of the European Union, 2018).

8.3 ENTITIES ELIGIBLE TO OFFER APPRENTICESHIP PROGRAMMES

To ensure the success of the work-based learning (WBL), employer's engagement is essential to add value to learners' experience. The CHAISE consortium has multiple links to companies, training centers and associations specialised in Blockchain technology. Employers that match certain criteria should be eligible to undertake the WBL irrelevant of size. Local and small businesses may also offer practical training.

Different regulations may be in place in EU member states. The German system foresees a formal application of any company wanting to offer apprenticeship at the responsible chamber of commerce. Duties of entities offering apprenticeships are also defined under German law (see § 14, BBiG).

8.4 TRAINEE RIGHTS AND RESPONSIBLITIES

Different regulations for trainee rights and responsibilities may be in place in EU member states. German VET defines these for example in § 13 of the BBiG. On EU level the EFQEA (Council of the European Union, 2018) provides the following guidelines:

- Employer, training provider and trainee need to conclude a written agreement that defines rights and responsibilities of the trainee.
- Trainers in the workplace should provide guidance and regular feedback to trainees, VET training providers and trainers at the vocational school. In-company trainers should be supported in keeping their professional and didactic skills up-to-date.
- Trainees need to be insured according to sector and national legislation and receive social protection.
- Work, health and safety rules and regulation apply and are to be respected by the trainee.
- Successful entry into the labour market and a career should be facilitated. Trainees should be engaged and guided on their learning pathway.

8.4.1 Financing and costs

National legislation, regulations and financial mechanisms (EU funds and other) should foster WBL and companies must be made aware of funding opportunities (Cedefop, 2015). Employers can be incentivised by subsidies or tax deductions to intake specific target groups (i.e. Women, adults, immigrants, etc.).

Trainees should receive renumeration or other measures of compensation, in accordance with existing national requirements, sectoral or other collective agreements. Employers and public authorities may have arrangements on the sharing of costs.

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9 ANNEX 1: CONSULTATION PROCEDURE WITH QUALIFICATIONS BODIES

In this chapter (Annex 1), we describe the typical steps and tasks that should be followed regarding the recognition of qualifications at European level. At national level, we present as a case study Greece since the Greek Ministry of Education (YPEPTH) is taking part in CHAISE project and actively supports the recognition of Blockchain blueprint. Additionally, the future uptake of the Blockchain blueprint involved CHAISE partners UCBL, UT, INDUSTRIA, UPC, YPEPTH, ESRI who accessed national authorities in France, Estonia, Belgium, Spain, Greece and Ireland during April and March 2023. The guiding questions for the consultation procedure that is conducted via qualitative research (in-depth interviews or round-tables) are presented below:

- Where do you see the CHAISE VET programme structure fit best in your country's national qualification system?
- What benefits do you perceive for the recognition of the Blockchain Specialisation qualification at national level?
- What are the main obstacles for recognition of the Blockchain Specialisation qualification at national level?
- Which actors are in the best position to advance the recognition of the Blockchain Specialisation qualification at national level?
- What are the necessary steps for the recognition of the Blockchain Specialisation qualification at national level?
- Do you think that the Blockchain Specialisation qualification can acquire a recognised professional status via a sector regulated accreditation?
- Does the blueprint correspond to occupational requirements and applicable accreditation standards in your country? If no, please describe what needs to be added.

9.1 ACCREDITATION PROCEDURES AT EUROPEAN LEVEL

The design, approval and award of vocational qualifications in the EU member-states is regulated at national level, therefore it is examined each time considering the special educational context of the member-state. The national procedure from the CHAISE participating countries is gathered in Cedefop observatory for vocational education and training in the below links:

Table 20 VET Qualifications in CHAISE participating countries

Country	Cedefop website link	Section
France	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/france-u2	Most relevant sections: VET governance Shaping VET qualifications Quality assurance
Belgium	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/belgium-u2	
Austria	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/austria-u2	
Greece	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/greece-u2	
Germany	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/germany-u2	
Spain	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/spain-u2	
Italy	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/italy-u2	
Estonia	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/estonia-u2	
Slovenia	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/slovenia-u2	
Romania	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/romania-u2	
Bulgaria	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/bulgaria-u2	
Ireland	https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/ireland-u2	

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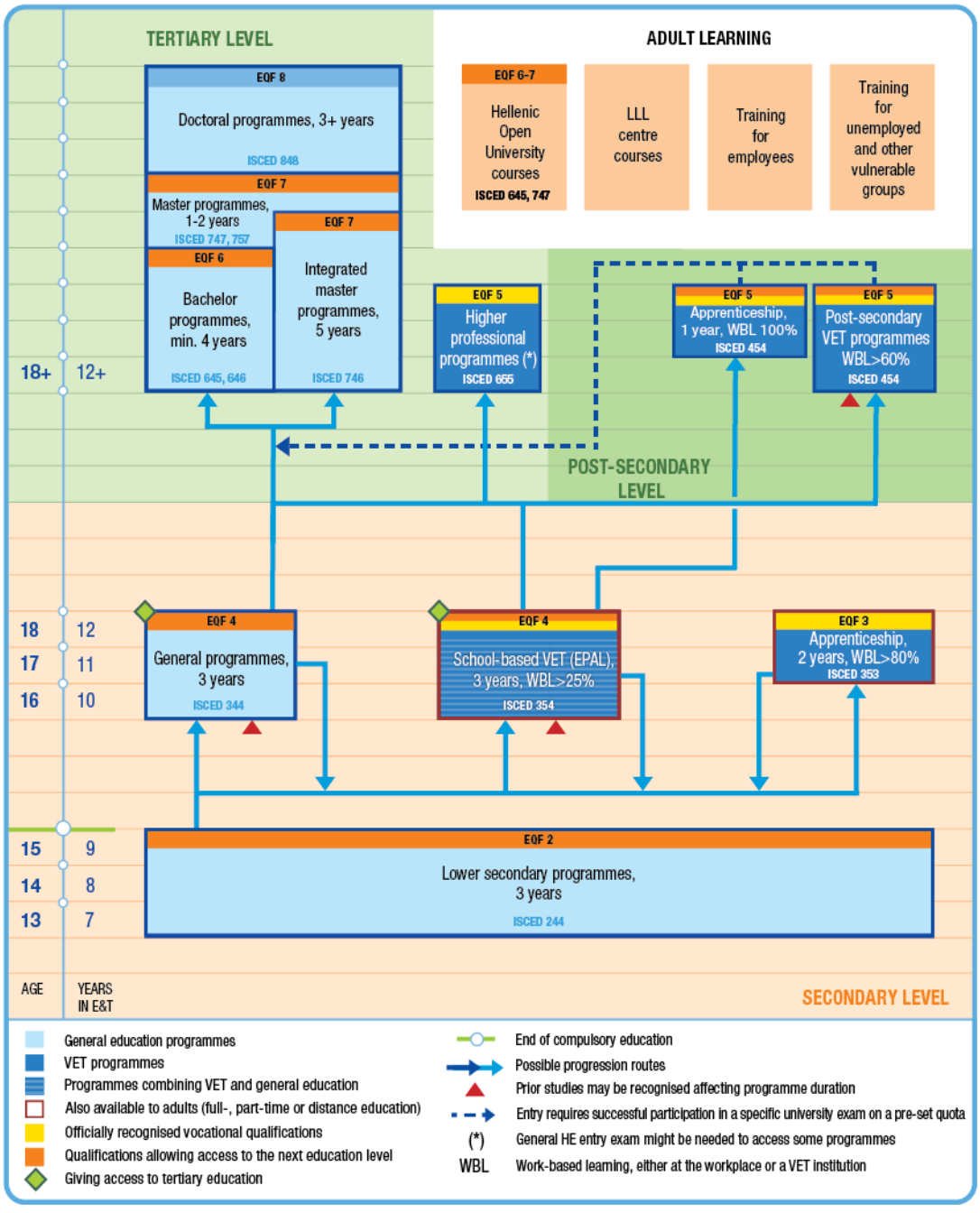
9.2 ACCREDITATION PROCEDURES AT NATIONAL LEVEL: THE GREEK CASE

An important stage in shaping VET qualifications is to have suitable forecasting mechanisms (Cedefop, 2021b). Based on Greek Law 4368/2016 and Ministerial Decree 4013/410/26.05.2016 on the introduction and operation of a relevant network and the supportive information system, Greece introduced a mechanism for addressing the early identification of labour market needs at medium-term level, for designing employment policies that correspond to training and education programmes and for providing labour market information to support evidence-based policy making.

The responsible body for the development of the labour market diagnosis is the Independent Administrative Body National Institute for Labour and Human Resources (EIEAD). EIEAD along with a committee represented from ministries of labour, education and economy, EOPPEP, regions, OAED and social partners publishes every 6 months results on recent developments and trends of new occupational profiles.

Regarding the design of qualifications in upper secondary vocational programmes (EPAL), these are determined by Minister of Education decision. They should reflect the consultation procedure (conducted in an unstructured manner) with regional VET boards, social partners, chambers and relevant actors from the involved ministries (economy, labour). The curricula of post-secondary VET programmes (IEK) are developed by the General Secretariat for vocational education, training and lifelong learning in accordance with existing occupational profiles. The reform law 4386/2016 requires the assessment of curricula and their revision through new education material and training of teachers. In the apprenticeship programmes that are decided by the National Committee for VET and Apprenticeships based on a Technical Committee recommendation report, the update of them is conducted considering the labour market forecasting mechanisms. Another recent development is the establishment of the Hellenic Qualification Framework (HQF) by the law 4763/2020 which main role is the classification of all qualifications in both formal and non-formal education. The implementation of HQF is conducted by EOPPEP that serves also as the national coordination point for EQF in Greece based on the eight EU levels. Based on Cedefop (2021b), EOPPEP included in the qualifications database around 500 new qualifications following the learning outcomes principle.



NB: ISCED-P 2011.
Source: Cedefop and ReferNet Greece, 2022.

Figure 6 VET system in Greece (adopted from Cedefop and ReferNet Greece, 2022)

9.3 RESULTS OF CHAISE CONSULTATION PROCEDURE

To be updated in due time

The results of the consultation procedure with national authorities are mapped in the below table:

Table 21 National authorities' consultation

Country	CHAISE partner	National authority	Date of interview	Duration of interview	Nr. of participants
France	UCBL				
Estonia	UT				
Bulgaria	INDUSTRIA				
Greece	YPEPTH				
Spain	UPC				
Ireland	ESRI				

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10 ANNEX 2: PLANNING STEPS FOR FUTURE ACCREDITATION

To plan the steps for future accreditation it is important to understand how the National Qualifications Frameworks (NQFs) are developed. Cedefop (2020a) describes the cyclical character of NQF development in six stages in which evaluation forms constitute essential part for the continuous adaptation to stakeholders requirements:

1. **explorative stage:** involves initial discussions on policy challenges, identification of problems, strengths and weaknesses of current NQF;
2. **design stage:** an outline is designed serving as a basis for dissemination and discussion with stakeholders;
3. **adoption stage:** further to a testing period, usually as a public consultation process, the proposed NQF is adopted in the form of a decree/law or a formal agreement;
4. **activating stage:** the framework moves towards a full-scaled applied practice where public administration is getting prepared in terms of new structures, methods and end-users are informed about objectives and benefits of the framework;
5. **operational stage:** it is the full implementation stage where NQF meets the objectives that have been identified and negotiated in the previous stages;
6. **review stage:** framework is monitored and reviewed against new developments, evaluations and changes in stakeholders requirements.

The questions during the consultation procedure conducted under this report were based on the cyclical character of the NQF development process. The stages described above can be partly overlapping since there is not always a clear distinction between design-testing stages and implementation-review stages. For methodological reasons, current report assumes that the blueprint is referring mainly to the first three stages.

For planning the accreditation of BC occupational profiles should include the below steps:

Table 22 Accreditation planning steps

Blockchain blueprint		
Stage	**Indicators**	**Planning actions**
Explorative	Stage indicators: • Role of qualification framework and European practice is understood • Policy challenges, objectives and consultation with stakeholders have been identified • Anticipated benefits are described (ex ante) • Strengths and weaknesses of blueprint in relation to NQF are identified	Relevant actions: • Gathering of data from national skills gap analysis reports, market and education in the Blockchain area • Gathering of data from recent NQF developments in the respective country • Mapping in the form of a report the benefits, challenges and weaknesses of the blueprint
Design	Stage indicators: • Coalition of stakeholders established • Outline is designed and agreed to be disseminated with stakeholders/national authorities • End-users are being made aware of the existence of blueprint	Relevant actions: • Mapping all stakeholders from public and private sector representing education and market domain • Designing of an action plan mentioning the specific role of each stakeholder, the planned activities and timeframe • Designing of public events targeting end-users for raising awareness on the need for a new occupational profile
Adoption	Stage indicators: • A roadmap with activities and actions for testing period is established • National authorities and qualification bodies report opportunities and challenges for adopting the blueprint	Relevant actions: • Implementing a testing period for the occupational profile • Reporting on the results of the previous stages from national authorities perspective • Signing of formal agreements with stakeholders, regional committees

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Blockchain blueprint		
	• Formal agreements are signed among stakeholders and actors that are then presented to national authorities for planning legislative changes	in Blockchain area in the form of Memoranda of Understanding • Preparing law proposals to be incorporated in existing legislation in the Blockchain area
Activating	Stage indicators: • Qualification is perceived by national authorities, stakeholders and end-users as a full-scaled applied practice • Stakeholders are fully informed about the objectives and benefits of the qualification • End-users are fully informed about the objectives and benefits of the qualification	Relevant actions: • Designing change management plans for national authorities and stakeholders regarding the updated/new qualification • Arranging info-days for end-users and external stakeholders • Arranging internal trainings for national authorities
Operational	Stage indicators: • A roadmap with activities and actions for testing period is established • Qualification is being adopted by national authorities • Qualification is incorporated in qualifications registries or national databases • Quality assurance mechanisms for the design, registration, renewal of qualifications are put in place	Relevant actions: • Registering data extracted from updated/new occupation into national qualification databases • Preparing a data management plan on how data can be extracted, exploited and be used for the periodic monitoring of the qualification
Review	Stage indicators: • An evaluation plan is established for a 6-month and annual monitoring of changes in the education and labour market • An observatory is established with recent national and European developments in Blockchain	Relevant actions: • Creating evaluation plans based on 6-month and annual reports on the changes and developments in the occupation area • Establishing structured review mechanisms for the qualification

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11 ANNEX 3: LEARNING OUTCOMES OF CHAISE VET PROGRAMME

Table 23 Learning outcomes “Introduction to Blockchain Technology”

1. INTRODUCTION TO BLOCKCHAIN TECHNOLOGY		
Explain the main components of the blockchain technology, recognise its application sectors and discuss the key historical facts of blockchain technology development.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Key blockchain technology components and application sectors - Main historical facts of the blockchain technology development	Able to: - **LO1.2:** Describe the main concepts and components of the Blockchain technology - **LO1.2:** Recognise the sectors where the blockchain technology can be applied - **LO1.3:** Recall the main historical facts of the blockchain technology development.	Capable to: - Share ideas about the blockchain application sectors. - Participate in discussion on the blockchain technology history.
EQF level	**EQF Level 5**	

Table 24 Learning outcomes “Regulation, legal aspects, and governance of Blockchain systems”

2. REGULATION, LEGAL ASPECTS, AND GOVERNANCE OF BLOCKCHAIN SYSTEMS		
Explain blockchain-related regulations, legal aspects, governance, and their impact in the public and private sectors.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Blockchain-related legal environment. - Legal underpins of Blockchain technology and smart contracts. - Legal implications of cryptocurrencies. - Legal status of the decentralised autonomous organizations. - GDPR requirements and consent management - Blockchain and public policy, governmental regulations - Implications of blockchain technology for society, regulators, policy makers, governments, law professionals.	Able to: - **LO2.1:** Describe blockchain-related legal environment in Europe and the World. - **LO2.2:** Explain regulatory framework of blockchain based financial services. - **LO2.3:** Recognise legal and regulatory issues and risks when dealing with cryptocurrency and blockchain technology. - **LO2.4:** Discuss the interest of Blockchain technology to manage consent and data access - **LO2.5:** Explain implications of blockchain technology for governments, policy makers, law professionals, regulators and society.	Capable to: - Practice critical thinking of the blockchain legal environment and regulations. - Take responsibility when deciding about the blockchain, cryptocurrencies and use of smart contracts. - Identify consent management and data usage tracking requirements - Participate in discussion regarding blockchain technology impact and blockchain governance decisions.

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	- **LO2.6:** Illustrate the impact of the blockchain governance on policy effectiveness.	
EQF level	**EQF Level 5**	

Table 25 Learning Outcomes of "Fundamentals of Blockchain and Distributed Ledger Technology"

3. FUNDAMENTALS OF BLOCKCHAIN AND DISTRIBUTED LEDGER TECHNOLOGY		
Use the blockchain terminology and discuss differences between the centralised databases and distributed ledger, explain blockchain characteristics, components and main security principles.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Blockchain terminology, differences between centralised database and distributed ledger. - Decentralised applications, network performance, smart contracts, public/private/consortium networks. - Blockchain-based application components (e.g., peer-to-peer network, smart contracts, consensus, etc.) - Basic principles of the blockchain-based application security	Able to: - **LO3.1:** Explain main terminology of blockchain and distributed ledger technology - **LO3.2:** Discuss mechanics of decentralised applications. - **LO3.3:** Describe characteristics and components. - **LO3.4:** Explain security features of the blockchain applications.	Capable to: - Present and discuss differences between the centralised and decentralised applications. - Share ideas about main blockchain characteristics, components and security features. - Express the professional attribute towards the blockchain technology. - Learn and self-reflect as a blockchain expert in the given environment, including the ability to leverage communities and digital learning activities for further development.
EQF level	**EQF Level 5**	

Table 26 Learning Outcomes of "Blockchain Business Management and Planning"

4. BLOCKCHAIN BUSINESS MANAGEMENT AND PLANNING		
Describe the blockchain suitability for the business process innovation, discuss the fundamentals of blockchain use cases and use case implementation.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Fundamental principles of the blockchain technology suitability for business innovation. - Criteria of blockchain technology to be applicable in the business use cases. - Different application areas / industries for a meaningful use of blockchain technology - Ethical and environmental aspects associated with blockchain.	Able to: - **LO4.1:** Explain what capabilities of blockchain technology enable innovating existing businesses and processes. - **LO4.2:** Describe the fundamental business model of blockchain use cases. - **LO4.3:** Analyse different implementations of blockchain business use cases. - **LO4.4:** Examine when blockchain technology	Capable to: - Demonstrate decision making confidence to use blockchain technology to business management and planning. - Handle risks appearing within blockchain use case development. - Generate innovative blockchain application ideas that create value and business processes. - Critically analyse, ethical evaluate and assess the use cases of Blockchain application.

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	becomes a viable option for a business use case.	
EQF level	**EQF Level 5**	

Table 27 Learning Outcomes of "Blockchain Security and Digital Identity"

5. BLOCKCHAIN SECURITY AND DIGITAL IDENTITY		
Describe how blockchains may secure data and information by utilizing the transaction protection and validation principles of blockchains, access control and digital identity principles		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Information and data security principles. - Countermeasures to secure blockchain transactions. - Security challenges and smart contract vulnerabilities. - Blockchain access control principles. - Digital identity management principles.	Able to: - **LO5.1:** Describe how blockchains may secure data, information, and processes by utilizing the transaction protection and validation principles of blockchains. - **LO5.2:** Recognise security vulnerabilities and emerging security challenges in blockchain-based applications, as well as the security flaws in smart contracts. - **LO5.3:** Explain identity management principles and access control models within blockchain-based applications. - **LO5.4:** Describe blockchain-based personally identifiable information, self-sovereign identity, and decentralised identifiers (DIDs) to address digital identity problems.	Capable to: - Integrate security and digital identity solutions to the blockchain application design. - Take responsibility of the proposed blockchain security solution. - Challenge new ideas towards blockchain security solutions. - Share and agree about the blockchain security solutions with project stakeholders. Demonstrate how security countermeasures and digital identity solutions change the trustworthiness level of blockchain application.
EQF level	**EQF Level 5**	

Table 28 Learning Outcomes of "Blockchain System Architecture and Consensus Protocols"

6. BLOCKCHAIN SYSTEM ARCHITECTURE AND CONSENSUS PROTOCOLS		
Construct architecture of blockchain-based applications, apply design patterns, compare different consensus protocols.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Design process for blockchain systems. - Blockchain design patterns, e.g., Merkel root for verifiable inclusion, longest chain, BFT for finality.	Able to: - **LO6.1:** Explain fundamental design and architectural primitives of DLT system architecture, e.g., trust-less, permissionless, asynchronous, sybil protection.	Capable to: - Utilise knowledge of the blockchain architecture to address customer needs in design solutions. - Practice different blockchain system architecture strategies to efficiently integrate solutions.

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- Consensus protocols (Proof of Work, Proof of stake, Proof of Capacity, Byzantine Fault Tolerance, etc.). - Infrastructure design, in particular P2P network.	- **LO6.2:** Employ design patterns and reusable proved solutions to explain blockchain system development. - **LO6.3:** Compare different consensus protocols. - **LO6.4:** Evaluate the blockchain architecture solutions to different practical scenarios. - **LO6.5:** Further develop existing blockchain architectures and apply them to new contexts in a creative way.	- Communicate the blockchain architecture solutions with customers and developer team members.
EQF level	**EQF Level 5**	

Table 29 Learning Outcomes of "Blockchain Platforms"

7. BLOCKCHAIN PLATFORMS		
Explain basic components and types of the blockchain platforms, demonstrate the node creation, account management and transaction principles.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Blockchain platforms, such as Ethereum, Hyperledger, IOTA, Corda, etc. - Principles of transaction, smart contract, and mining principles. - Network types and performance.	Able to: - **LO7.1:** Describe different blockchain platforms (e.g., Ethereum, Hyperledger, IOTA, Corda, etc.). - **LO7.2:** Explain blockchain technology ecosystem, underlying basic algorithms and essentials of trust. - **LO7.3:** Describe how blockchain technology works, what are principles of operations/ transactions, blocks, smart contracts, and mining. - **LO7.4:** Demonstrate the node creation on Ethereum, devise and unlock accounts, mine, transact, transfer, and check balances of Ethers.	Capable to: - Follow the up-to-date advances in the blockchain platform development - Change from the traditional centralised thinking to the decentralised (blockchain-oriented) understanding of the system. - Understand the responsibility of creating new nodes and participating in the blockchain network.
EQF level	**EQF Level 5**	

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Table 30 Learning Outcomes of "Marketing and Customer Support"

8. MARKETING AND CUSTOMER SUPPORT		
Demonstrate marketing, customer support principles for the blockchain technology.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Role of blockchain in marketing. - Customer success design. - Affiliate marketing.	Able to: - **LO8.1:** Explain the role of Blockchain for marketing. - **LO8.2:** Demonstrate strategies for customer support and service design. - **LO8.3:** Analyse role of networks and customer relationship management for blockchain technologies. - **LO8.4:** Illustrate products, prices, promotion, and sales strategies for blockchain technology. - **LO8.5:** Create awareness for blockchain use among broader audience and communicate the benefits of the technology in an accessible way for different use cases.	Capable to: - Share blockchain-based marketing strategies - Participate in the customer support activities - Display a willingness to communicate well with customers. - Organise marketing campaigns for blockchain technology. - Critically analyse, ethical evaluate and assess the marketing strategy for Blockchain application.
EQF level	**EQF Level 5**	

Table 31 Learning Outcomes of "Applied Cryptography"

9. APPLIED CRYPTOGRAPHY		
Apply major digital signature schemas, cryptographic protocols, and tools to protect blockchain-based applications.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Most used cryptographic primitives in BC - Cryptography measures used in transaction management, access control, privacy management. - Authentication, integrity protection methods. - Combine primitives to create secure protocol components.	Able to: - **LO9.1:** Apply fundamental concepts of hash function, Merkle tree commitment scheme, proof of inclusion. - **LO9.2:** Apply major signature schemes used in the blockchain technologies. - **LO9.3:** Employ cryptographic protocols and public key infrastructure for enforcing practical security goals in the blockchain-based applications. - **LO9.4:** Apply programming tools to implement cryptographic constructions used in the blockchain-based applications.	Capable to: - Apply the necessary techniques to secure transactions, access, integrity of the data. - Advise on the cryptographic protocols be used for designing a secure blockchain application. - Use the most relevant programming tools for implementing cryptography solutions.
EQF level	**EQF Level 5**	

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Table 32 Learning Outcomes of "Smart Contract Development"

10. SMART CONTRACT DEVELOPMENT		
Employ programming language(s) to develop smart contracts and digital currency.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Frontend and Backend development. - User experience (UX) design principles. - Smart contract design and implementation. - Programming languages (e.g., solidity, Rust, JavaScript, etc.)	Able to: - **LO10.1:** Apply good practices for developing smart contracts and describe the advantage of blockchain technology. - **LO10.3:** Analyse decentralised applications, tokenization, voting, auctions, remote selling and etc. - **LO10.3:** Apply smart contract programming language (i.e., syntax and concepts like state variables, storage, functions, visibility, mappings, etc). - **LO10.4:** Design, develop and deploy a smart contract for blockchain applications.	Capable to: - Relate the frontend and backend components of the blockchain-based application. - Integrate a creative environment to support observation, ideation, reflection, building and rebuilding of the blockchain-based application prototypes. - Coordinate with smart contract users and development teams to determine potential barriers and challenges. - Develop network of collaboration with other smart contracts and digital currency programmers.
EQF level	**EQF Level 5**	

Table 33 Learning Outcomes of "Developing Use Cases: From Ideas to Service"

11. DEVELOPING USE CASES: FROM IDEAS TO SERVICE		
Design heuristics for reaching customer needs, managing products and creating services using the blockchain-based applications.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Principles to identify the blockchain application customers. - Processes and method to redesign the traditional process flows to the blockchain-based use cases. - Product development principles using blockchain applications.	Able to: - **LO11.1:** Analyse the customer profile, debate different ways to innovate, and map the value proposition of a blockchain use case. - **LO11.2:** Redesign heuristics and model the process flow of the blockchain use case. - **LO11.3:** Collect and prioritise requirements for defining a minimal viable product (MVP) for the blockchain use case. - **LO11.4:** Manage the roadmap for the blockchain use case. - **LO11.5:** Transfer existing concepts of blockchain use cases to new contexts	Capable to: - Relate logical blockchain components for the business process, justify the adopted decision using measures. - Explain potential product or service's customer, including their goals, challenges, and aspirations. - Cooperate within diverse team to achieve goals of blockchain use cases. - Share and communicate knowledge about customers' needs, product specifics, and process heuristics among the use case team members.
EQF level	**EQF Level 5**	

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Table 34 Learning Outcomes of “Game Theory in Blockchains”

12. GAME THEORY IN BLOCKCHAINS		
Demonstrate how reason on the blockchain-based business and investment decision using the game theory model.		
Knowledge	**Skills**	**Responsibility and Autonomy**
Knows / Aware of: - Game theory concepts used in blockchain applications. - Game theory models applied in blockchain-based solutions.	Able to: - **LO12.1:** Illustrate basic concepts from game theory with a blockchain application for remote purchases. - **LO12.2:** Describe and define advanced concepts from game theory. - **LO12.3:** Discuss the theoretic game approach from the fees in a blockchain network. - **LO12.4:** Illustrate the game theory behind proof of stake.	Capable to: - Present game theory definitions and main concepts. - Explain game theory models applied in blockchain-based solutions. - Utilise the most adequate game theory models to illustrate blockchain investment strategies. - Advise business teams of the best solutions to employ blockchain technology.
EQF level	**EQF Level 5**	

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