WP2-A3. Definition of the learning objectives and learning outcomes of the curriculum.

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CONTENTS

1. INTRODUCTION

This deliverable, WP2-A3 "Definition of the learning objectives and learning outcomes of the curriculum", forms a key building block in the development of the RockChain educational programme. It represents a transition from the initial conceptual and strategic framework (defined in WP2-A1 and WP2-A2) to the pedagogical structuring of the curriculum, establishing a clear and measurable set of learning objectives and outcomes that will guide the design, implementation, and evaluation of the RockChain training offer.

RockChain addresses the need to upskill adult learners—particularly workers over 45 years old in the ornamental stone, construction, and waste management sectors—by equipping them with transversal digital competences, focusing especially on the application of blockchain technology in circular economy processes. As defined in the project application, the task WP2-A3 is dedicated to identifying and structuring the general learning objectives and expected learning outcomes, ensuring alignment with the European Qualifications Framework (EQF), the ESG for Quality Assurance, and the Council Recommendation on Key Competences for Lifelong Learning.

This report is based on the collaborative work of all project partners and builds directly on the early findings of WP2-A2 (Training needs analysis) as well as on the first version of the curriculum structure and methodology defined under WP2-A6. The outputs of WP2-A3 will serve as a reference for the definition of the learning methodology (WP2-A4), content development (WP3), and the design of the RockChain interactive learning tool (WP4). The current document presents:

(1) an overview of the preliminary approach to identifying learning outcomes;
(2) the final formulation of overarching learning outcomes—grouped into knowledge, skills, and attitudes/values—and;
(3) a set of conclusions to guide the pedagogical continuity of the curriculum.

The overall goal of this task is to ensure that the RockChain curriculum is not only technically coherent and pedagogically robust, but also relevant, inclusive and transferable, with clear and verifiable outcomes that meet the needs of learners, trainers, and stakeholders in the digital and green transition of the sector.

2. INITIAL APPROACH TO LEARNING OUTCOMES

The initial approach to defining the learning outcomes for the RockChain curriculum was grounded in the early results of the training needs analysis (WP2-A2) and in the practical and technological focus of the project itself—namely, the intersection between waste management in the ornamental stone sector and the application of blockchain technology to promote circular economy practices. This preliminary framework served as the foundation for iterative discussion among project partners and sectoral stakeholders during the first phase of curriculum design.

At this early stage, the consortium formulated provisional learning outcomes grouped under three core dimensions: knowledge acquisition, development of competences, and attitudinal change. These outcomes were articulated through thematic clusters covering two key knowledge domains:

(i) rock waste management in the stone industry and its associated logistics and environmental challenges, and;

(ii) blockchain technology and its potential application in waste traceability and resource optimisation. Within each domain, learning descriptors were drafted to reflect essential technical knowledge, relevant industrial practices, and contextual sustainability principles—including the promotion of stone as a reusable and low-impact material.

In parallel, initial competence-based outcomes were outlined to identify the specific skills and abilities learners would need in order to transfer theoretical knowledge into practical and sector-relevant actions. These included the capacity to interpret waste flows, assess recycling options, apply circularity principles, and simulate blockchain-based traceability workflows.

The consortium also acknowledged the importance of defining attitudinal outcomes—particularly in fostering commitment to sustainability, openness to technological innovation, ethical data practices, and intergenerational learning in traditional industrial environments. These preliminary outcomes provided a conceptual and operational scaffold, which was later refined and structured into the final framework of overall learning outcomes presented in Section 3 of this report.

2.1 Initial Knowledge Outcomes

A. Rock waste management in the stone industry and logistics:

- waste generation and environmental impact: understand the key sources of rock waste during mining, quarrying and stone processing and the environmental challenges associated with their management

- best practices in waste management: gain knowledge of industry-standard practices for minimizing, handling and recycling rock waste, including the logistics involved in the storage, transport and sale of stone blocks
- sustainability principles: learn the principles of sustainable waste management and circular economy in the stone industry, including strategies to reduce environmental footprints and improve resource efficiency.
- promoting stone as a green material: gain knowledge of strategies to advocate for the use of stone in a sustainable, emphasizing its role in reducing the carbon footprint in a raw material with high potential for reuse and recycling in various industrial applications.

B. Blockchain technology in waste management:

- blockchain fundamentals: acquire a solid understanding of the principles of blockchain technology, including its architecture, operations and potential applications
- blockchain in waste management: understand how blockchain can be applied to improve the traceability, transparency, and security of waste management processes in the stone industry
- case studies and real-world applications: gain insights from real-world examples of blockchain being used in the mining, quarrying and stone processing sectors and learn about the benefits and challenges of its implementation.

2.2 Initial outcomes

A. Rock waste management in the stone industry and logistics

A.1. Introduction to rock waste management

- overview of waste generation in the stone industry;
- environmental impacts and sustainability challenges;
- best practices in waste reduction, handling, and logistics.

A.2. Principles of the circular economy

- waste and waste recycling;
- reuse of waste;
- materials degradation.

A.3. Waste management in stone processing

- techniques for minimizing and recycling stone waste;
- innovations and challenges in stone waste management;
- case studies of successful waste management strategies.

B. Blockchain technology in waste management

B.1. Fundamentals of Blockchain technology

- principles and operation of blockchain;
- potential applications of blockchain in waste management;
- introduction to blockchain platforms and tools.

B.2. Blockchain in the mining and stone industries

- case studies of blockchain implementation in waste tracking.
- developing blockchain solutions for waste management.
- future trends in blockchain technology for the stone industry.

2.3 Initial expected results

A. Rock waste management in the stone industry and logistics

- foster a strong commitment to sustainability in the management of rock waste, emphasizing the importance of reducing environmental impact through responsible practices in mining, quarrying, and stone processing;
- cultivate an ethical approach to waste management in the stone industry, recognizing the need for transparency, accountability and long-term thinking in decisions related to waste handling, storage, and transport;
- encourage a proactive attitude toward identifying and addressing challenges in rock waste management.
- Instil a long-term perspective in decision-making related to natural stone waste, promoting consideration of life cycle impacts, durability and sustainability in the selection and use of this waste as raw material for reuse or recycling in other industries.

B. Blockchain technology in waste management

- develop an open and innovative mindset toward the adoption of new technologies like blockchain, recognizing their potential;
- develop a meticulous attitude towards data accuracy, security and integrity when using blockchain for tracking and managing waste;
- promote a collaborative approach to implementing blockchain solutions, encouraging teamwork and cross-disciplinary cooperation.

3. LEARNING OUTCOMES

This section presents the final and consolidated set of learning outcomes that define the RockChain curriculum. They reflect the transition from initial outcome proposals (as outlined in Section 2) to a structured and validated framework aligned with the pedagogical principles of the project, the training needs identified in WP2-A2, and the European Qualifications Framework (EQF).

The learning outcomes are organised into three main categories:

- Expected knowledge outcomes,
- Expected outcomes of competences, and
- Expected attitudinal results.

Together, these categories form a comprehensive and coherent learning architecture, ensuring that learners not only acquire technical knowledge and digital skills, but also develop a mindset of sustainability, innovation, and professional growth. The formulation of these outcomes is designed to guide the design of learning methodology (WP2-A4), the development of content and materials (WP3), and the implementation of practical learning experiences (WP4).

Knowledge Domain	Learning Outcomes
Knowledge of the Ornamental Rock Sector and Its Environmental Challenges	- The structure and functioning of the ornamental rock value chain, from extraction and transformation to distribution and end use, including the key actors and interdependencies across the supply chain. - The types of ornamental stone materials (e.g. marble, granite, slate, limestone), their properties and their typical applications in construction, urban design, and architecture. - The technical and economic characteristics of waste generated in the stone industry, including fine particles, saw sludge, broken pieces and quarry residues. - The environmental implications of waste mismanagement, such as land occupation, air and water pollution, and inefficient use of natural resources. - The key challenges facing the sector, including low digitalisation, rising regulatory demands, lack of skilled workforce, and public pressure for sustainable practices.
Knowledge of Circular Economy Principles and Waste Valorisation	- The core concepts of the circular economy (CE), including closed-loop systems, waste-as-resource, extended product lifecycles, and systemic thinking. - The differences between linear and circular models, and the advantages of CE approaches in terms of economic resilience, material efficiency and regulatory alignment. - Strategies for circularity in the stone sector, including by-product valorisation, secondary raw materials, industrial symbiosis and design for reuse.

	- The European and national regulatory frameworks related to circular economy and waste (e.g. Waste Framework Directive, Construction and Demolition Waste Protocol, EU Green Deal). - The notion of zero impact and regenerative design, particularly in relation to quarry rehabilitation, eco-design of products, and emissions reduction.
Knowledge of Blockchain and Digital Traceability Systems	- The basic architecture of blockchain systems, including blocks, hash functions, distributed ledgers, consensus protocols, nodes, and transaction validation. - The main benefits of blockchain in industrial contexts: immutability, decentralisation, trustless verification, transparency and fraud prevention. - The concept and functioning of smart contracts, including their potential for automating compliance, workflow coordination, and environmental reporting. - Differences between blockchain and traditional databases, including data integrity, accessibility and security mechanisms. - The role of blockchain in traceability systems, allowing secure registration of origin, movement, treatment and reuse of materials and waste across multi-actor chains. - How blockchain can be combined with other technologies such as IoT, smart sensors, digital twins and cloud systems to reinforce the reliability and auditability of data.
Knowledge of Digitalisation, Green Transition and Lifelong Learning	- The transformative role of digital technologies in modernising traditional sectors and improving environmental outcomes through better data, monitoring and automation. - The relationship between digitalisation and the Green Deal, particularly in the context of the twin transition and the European Skills Agenda. - The importance of data ethics, cybersecurity and responsible digital practices, especially when managing environmental or operational data across stakeholders. - The need for lifelong learning and continuous upskilling, especially for professionals over 45 in low-digital sectors, to adapt to new tools and expectations. - The social, organisational and cultural dimensions of digital transformation, including resistance to change, digital literacy gaps, and intergenerational learning. - The potential for empowerment and inclusion through accessible training programmes such as RockChain, which allow adult learners to regain confidence and relevance in the labour market.

Competence Domain	Expected Outcomes
Sectoral and Technical Competences	- Map and analyse the ornamental rock value chain, identifying the stages where waste is generated and where circular strategies could be introduced or strengthened. - Characterise different types of stone waste, assessing their physical and chemical properties and their potential for reuse, recycling or recovery. - Evaluate current waste management practices in the stone sector and contrast them with circular economy principles and regulations. - Propose circular alternatives for stone waste, considering technical feasibility, environmental impact, market demand and cost-effectiveness. - Design or interpret basic flow diagrams of stone waste management systems, identifying critical control points for traceability and compliance.
Digital and Blockchain Competences	- Describe the fundamental logic of blockchain systems, including how information is stored, secured and shared across decentralised networks. - Operate within a simplified blockchain learning environment, including the ability to input data, monitor transactions and simulate smart contract behaviour. - Apply blockchain logic to traceability workflows, identifying how material data can be recorded, verified and linked to actors within the value chain. - Design basic smart contract scenarios for waste handling, such as automatically recording delivery confirmations, flagging non-compliance or triggering alerts when thresholds are exceeded. - Link blockchain data to real-world inputs from sensors or monitoring systems, ensuring data accuracy and reducing risks of manipulation.
Sustainability and Circular Economy Competences	- Explain the principles of the circular economy and how they apply to the stone industry and other material-intensive sectors. - Interpret environmental regulations and sustainability criteria, including EU waste hierarchy, EPR (Extended Producer Responsibility), and the EU Taxonomy Regulation. - Integrate circularity and sustainability principles into technical decision-making, balancing operational, environmental and economic factors. - Critically assess the environmental impact of linear processes, and propose alternative models aligned with climate-neutral and zero-waste objectives. - Communicate sustainability-related improvements clearly and effectively to colleagues, clients or institutional stakeholders.
Transversal and Soft Competences	- Problem-solving and critical thinking, particularly when integrating new technologies into traditional sectors. - Teamwork and collaboration, including the ability to work across disciplines (e.g., IT and environmental management) and communicate with stakeholders of varying technical backgrounds. - Adaptability to technological change, cultivating a learning mindset in the face of Industry 4.0 developments. - Digital literacy, beyond blockchain, including safe and responsible use of digital tools, basic data management, and interpretation of digital workflows. - Technical communication, with the ability to document, present and explain technical processes clearly using appropriate terminology.

Attitudinal Domain	Expected Results
Attitudes Towards Sustainability and Circular Economy	- A genuine commitment to sustainability as a guiding principle in their professional practice, particularly in relation to resource efficiency, waste reduction and environmental protection. - An appreciation of circular economy thinking, not merely as a compliance obligation but as a strategic opportunity for value creation and innovation within the stone sector. - A willingness to question established practices and embrace process redesigns that favour environmental regeneration and reduced extraction. - A growing awareness of the long-term impacts of industrial activity on ecosystems, climate, and communities.
Attitudes Towards Digital Innovation and Technology Adoption	- An open and curious mindset toward new technologies, including blockchain, even when unfamiliar or outside of prior experience. - Increased confidence in experimenting with digital tools, platforms, and interfaces, and reduced resistance to technological change. - A constructive attitude towards learning, including self-directed learning and upskilling as ongoing professional responsibilities. - A proactive stance towards integrating digital solutions in traditional work environments, understanding their potential to improve transparency, traceability and collaboration.
Attitudes Towards Collaboration, Ethics and Professional Growth	- A collaborative spirit, valuing cross-sector and intergenerational exchange of knowledge, particularly in multidisciplinary teams dealing with sustainability and digital transformation. - A strong sense of professional ethics, including respect for data integrity, transparency, and fair stakeholder engagement in traceability systems. - A sense of initiative and autonomy, recognising their role not only as learners but as potential change agents within their organisations. - Greater self-esteem and motivation, stemming from the ability to engage with emerging technologies and participate in projects of relevance and impact.
Overall Expected Attitudinal Impact	- The understanding that the stone sector is evolving, and that environmental and digital pressures are not threats, but levers for transformation. - The recognition that their role as mature professionals is essential—precisely because of their sectoral experience, operational knowledge, and newfound digital awareness.

4. CONCLUSIONS

The work carried out under WP2-A3 marks a crucial milestone in the development of the RockChain training programme. Through a collaborative and iterative process involving all project partners, this deliverable has successfully defined a coherent, relevant, and future-oriented set of learning outcomes that will guide the structure and delivery of the curriculum in the next project phases.

The transition from the initial approach—based on training needs analysis and early stakeholder input—to a consolidated set of knowledge, competences and attitudinal outcomes ensures both alignment with EU frameworks (EQF, Key Competences, Green Deal) and responsiveness to the real challenges of the target sectors. The integration of sustainability principles, circular economy practices, and digital technologies such as blockchain into the curriculum reflects not only technological progress, but also a pedagogical vision that empowers learners—particularly those over 45—to become active contributors in the twin transition.

Moreover, the holistic nature of the defined learning outcomes ensures that learners will not only acquire technical knowledge, but also develop the competences and mindset needed to foster innovation, collaboration, and ethical transformation in their professional environments. These outcomes will serve as a robust foundation for the upcoming tasks: the design of the learning methodology (WP2-A4), the development of training content (WP3), and the deployment of the RockChain learning tool (WP4).

Ultimately, WP2-A3 ensures that the RockChain curriculum is ready to deliver measurable impact—bridging the digital and green skills gap in the ornamental stone and waste management sectors, while fostering long-term professional empowerment and systemic sustainability.