WP3-A1. Comparative study of Rock Ornamental Waste management regulations in each country.

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Contents

1. INTRODUCTION

This document summarizes the findings of activity WP3-A1, which compares the legal frameworks governing ornamental stone waste management in Germany, Spain, Romania, and Croatia. The focus is on how national and EU regulations address waste from materials like marble, granite, and slate, particularly during extraction and processing.

The analysis responds to a key challenge: regulatory fragmentation across EU Member States. Differences in how waste is classified and recovered often block companies from adopting circular practices, despite the goals set by the European Green Deal.

The report highlights these gaps and identifies best practices that could support a more unified approach. These insights are essential for the RockChain Project, as they establish the legal foundation needed to implement digital traceability tools such as blockchain. By aligning these technologies with current regulations, the project supports a more transparent and resource-efficient future for the natural stone sector in Europe.

2. GENERAL REGULATORY FRAMEWORK FOR ORNAMENTAL WASTE MANAGEMENT IN EUROPE

2.1. Overview of european regulations

The main legislative reference for waste management in the EU is the Waste Framework Directive (2008/98/EC), which sets out common definitions and principles, including the "waste hierarchy": prevention, reuse, recycling, recovery, and disposal as a last resort.

In the case of ornamental stone (granite, marble, slate), solid residues like offcuts and sludge are generally treated as Construction and Demolition Waste (CDW). The Directive set a target for Member States to prepare at least 70% (by weight) of non-hazardous CDW for reuse or recycling by 2020.

While the Directive provides a common baseline, Member States are responsible for transposing it into national law. As a result, companies must comply with both EU-level rules and specific local regulations in their country of operation.

2.2. Key strategic guidelines

Three major EU policies shape the broader direction of ornamental waste management:

- **The European Green Deal (2019):** Sets the goal of a climate-neutral EU by 2050 and emphasizes reducing industrial waste and promoting more efficient use of natural resources.
- **Circular Economy Action Plan (2020):** Supports product designs that enable reuse and recycling. In the stone sector, this encourages the recovery of by-products and secondary aggregates, reducing reliance on virgin materials.
- **Waste Framework Directive (2008/98/EC):** Defines key concepts like "waste" and "recycling," and requires Member States to adopt measures that prevent waste generation, particularly at extraction and processing sites.

2.3. Current context and implementation challenges

Despite strong EU policies, several challenges hinder effective implementation across the natural stone industry:

- **Product vs. Waste Classification:** The distinction between by-products and waste is not always clear. In some regions, reusable offcuts are still treated as waste, making reuse unnecessarily complex.

- **Logistical Fragmentation:** The sector is dominated by SMEs, which makes it hard to coordinate recycling systems or implement Extended Producer Responsibility (EPR) schemes for heavy materials.
- **Sludge Management:** Fine stone sludge from sawing and polishing poses technical challenges. Unlike inert solids, sludge requires dewatering and often lacks approved recovery routes.
- **Regulatory Inconsistency:** Frequent changes and inconsistent interpretations, especially across regions within countries, create uncertainty for businesses trying to adopt circular practices.

Tackling these issues is key to aligning the sector with the goals of the European Green Deal and unlocking the full potential of circularity in natural stone.

3. COMPARATIVE REGULATORY ANALYSIS BY PARTICIPATING COUNTRY

3.1. Germany: detailed regulatory context on ornamental waste management

The German regulatory framework for waste management in the ornamental stone sector combines robust waste legislation with specific regulations for extractive activities.

In practice, waste management obligations in the ornamental stone value chain cover:

- **Classification**: Mandatory assignment of waste codes according to the European Catalogue.
- **Traceability**: Detailed documentation of waste flows and separation.
- **Operations**: Requirements for storage, transport, and treatment.
- **Recovery versus disposal**: Strict conditions for landfilling and regulated use of mineral waste in construction.

A key piece of legislation is the Abfallverzeichnis-Verordnung (AVV), which implements the European Waste Catalogue in Germany and requires the use of six-digit codes on all transport and treatment documents. In addition, quarries must comply with both environmental regulations and the Bundesberggesetz (Federal Mining Act), which requires waste management plans as part of site operation and closure.

3.1.1. National Legislation

Kreislaufwirtschaftsgesetz (KrWG) – Circular Economy Act

Framework law defining the waste hierarchy, producer responsibility, and obligations regarding prevention, recycling, and disposal, forming the basis of German waste regulation.

Abfallverzeichnis-Verordnung (AVV) – Waste Catalogue Ordinance

Implements the European Waste Catalogue in Germany, listing the waste codes required for transport and treatment.

Ersatzbaustoffverordnung (ErsatzbaustoffV) – Substitute Building Materials Ordinance

Defines the environmental requirements for using mineral waste (such as aggregates or sludge) in technical construction applications and facilitates its recognition as a secondary raw material

Nachweisverordnung (NachwV) – Records Ordinance

Regulates documentation requirements for waste recovery and disposal, including electronic records for controlled waste movements.

Anzeige- und Erlaubnisverordnung (AbfAEV) – Notification & Permit Ordinance

Establishes notification and permit obligations for waste managers, transporters, and dealers.

Deponieverordnung (DepV) – Landfill Ordinance

Sets technical requirements and acceptance criteria for landfills; relevant when recovery is not possible.

Bundesberggesetz (BBergG) – Federal Mining Act

Framework regulation for exploration and extraction activities, combined with environmental regulations on waste and safety at extraction facilities.

3.1.2. Related DIN and EN Standards

In Germany, harmonized European standards (EN standards) adopted as DIN EN standards by the national standards body DIN (Deutsches Institut für Normung) apply, which support CE marking under the Construction Products Regulation.

The most relevant standards for natural stone products and testing are listed below):

DIN EN 1342:2013: Setts of natural stone for external paving: requirements and test methods.

DIN EN 1343:2013: Kerbs of natural stone for external paving: requirements and test methods.

DIN EN 1467:2022: Natural stone: rough blocks: requirements.

DIN EN 1468:2023: Natural stone: rough slabs: requirements.

DIN EN 1469:2015: Natural stone products: slabs for cladding: requirements.

DIN EN 12057:2015: Natural stone products: modular tiles: requirements.

DIN EN 12058:2015: Natural stone products: slabs for floors and stairs: requirements.

DIN EN 12059:2012: Natural stone products: dimensional stone: requirements.

DIN EN 12326-1:2014: Slate and stone products for discontinuous roofing and cladding: product specification.

DIN EN 14231:2003: Natural stone test methods: determination of slip resistance by means of the pendulum tester.

DIN EN 13755:2008: Natural stone test methods: determination of water absorption at atmospheric pressure.

DIN EN 1936:2007: Natural stone test methods: determination of real density, apparent density and total/open porosity.

DIN EN 1926:2007: Natural stone test methods: determination of uniaxial compressive strength.

DIN EN 1925:1999: Natural stone test methods: determination of water absorption coefficient by capillarity.

DIN EN 12371:2010: Natural stone test methods: determination of frost resistance.

DIN EN 14066:2013: Natural stone test methods: resistance to ageing by thermal shock.

DIN EN 14146:2004: Natural stone test methods: dynamic modulus of elasticity by resonance frequency.

DIN EN 14580:2005: Natural stone test methods: static modulus of elasticity.

DIN EN 14579:2005: Natural stone test methods: determination of sound propagation speed.

DIN EN 14157:2017: Natural stone test methods: determination of abrasion resistance.

DIN EN 14158:2004: Natural stone test methods: determination of flexural strength.

3.2. Spain: detailed regulatory context on ornamental waste management

Waste management in the ornamental stone industry in Spain is generally governed by laws, decrees and technical standards which attempt to minimize the environmental impact of excavation and transformation of natural stone. The regulation incorporates the sustainability objectives promoted by the European Union, responding to the specific needs of the sector where such activities generate huge volumes of waste mainly in the form of quarry rubble, cutting sludge and stone dust.

Spain, a part of the EU, has adapted its national legislation to the EU directives on waste and sustainable mining by specific regulations for the natural stone industry and its environmental impacts. However, despite these efforts, effective management of waste in this sector is still facing a range of technical, economic and regulatory challenges: e.g. the absence of complete harmonization in applying norms across autonomous communities or traceability difficulty for recycled materials.

This section seeks to give a thorough appraisal of the current regulations in Spain as regards waste management in the ornamental stone industry. It will go as far as broadening the scope of the most relevant laws and decrees that regulate the sector to UNE and ISO standards that establish the technical criteria applicable. It would also

determine the level of application of the regulations and illustrate good practices, existing challenges, and opportunities for improvement in sectoral efficiency through harmonization regulatory approaches and increased technologies such as Blockchain for traceability and legal compliance.

3.2.1. National Legislation

Law 7/2022, of April 8, on waste and contaminated soils for a circular economy: This law aims to prevent and reduce the generation of waste, as well as to improve efficiency in the use of resources, promoting the transition to a circular economy (BOE num. 85, 2022).

Royal Decree 646/2020, of July 7, regulating the disposal of waste by landfill: This decree establishes the conditions for the disposal of waste in landfills, ensuring that it is carried out in a way that avoids or reduces negative effects on the environment and human health (BOE num. 187, 2020).

Royal Decree 105/2008, of February 1, 2008, which regulates the production and management of construction and demolition waste: This decree establishes the legal framework for the management of waste generated in construction and demolition activities, including those from the ornamental stone industry.

Law 26/2007, of October 23, 2007, on Environmental Liability: This law establishes the legal regime for environmental liability based on the "polluter pays" principle, applicable to activities that may cause damage to the environment.

Law 22/2011, of July 28, 2011, on waste and contaminated soils: Predecessor of Law 7/2022, this law incorporated the European Union Waste Framework Directive into the Spanish legal system, establishing the bases for the management of waste and contaminated soils. (BOE num. 85, 2022).

3.2.2. Related UNE and ISO Standards

The following technical standards provide specific guidelines for the management and evaluation of natural stone products.

UNE-EN 1342:2013: establishes requirements and test methods for natural stone tiles used as exterior paving.

UNE-EN 1467:2024: Defines the requirements for raw blocks of natural stone.

UNE-EN 1468:2024: Specifies the requirements for rough natural stone slabs.

UNE-EN 14231:2004: Describes the test method to determine the slip resistance of natural stone by means of the friction pendulum.

UNE-EN 1469:2015: Establishes requirements for natural stone slabs used in wall coverings.

UNE-EN 12057:2015: Specifies the requirements for natural stone platelets.

UNE-EN 12058:2015: Defines requirements for natural stone tiles intended for paving and stairs.

UNE-EN 12372:2022: Provides the test method to determine the resistance to bending under concentrated load in natural stone.

UNE-EN 16306:2022: Establishes the test method to determine the resistance of marble to thermal and humidity cycles.

UNE-EN 16301:2022: Describes the test method to determine the sensitivity of natural stone to accidental stains.

UNE 22988:2022: Provides the digital performance declaration for natural stone products in accordance with EN 12058:2004.

UNE-EN 771-6:2012+A1:2016: Specifies natural stone masonry pieces.

UNE 22987:2022 IN: Provides technical specifications for natural stone products intended for construction.

UNE-EN 12370:2020: Establishes the test method to determine the resistance of natural stone to salt crystallization.

UNE-EN 13373:2020: Describes the test method to determine the geometric characteristics of natural stone units.

UNE-EN 12326-2:2012: Provides test methods for slates and carbonated slates used in pitched roofing and cladding.

UNE-EN 12326-1:2015: Specifies the characteristics of slates and carbonated slates for pitched roofing and cladding.

UNE-EN 772-4:1999: Establishes the test method to determine the real and apparent density, as well as the porosity of natural stone pieces for masonry.

UNE-EN 1925:1999: Describes the test method to determine the coefficient of water absorption by capillarity in natural stone.

UNE-EN 14158:2004: Provides the test method to determine the breaking energy of natural stone.

UNE-EN 14146:2004: Establishes the test method to determine the dynamic modulus of elasticity of natural stone by measuring the fundamental resonance frequency.

UNE-EN 14580:2006: Describes the test method to determine the static modulus of elasticity of natural stone.

UNE-EN 13755:2008: Specifies the test method to determine water absorption at atmospheric pressure in natural stone.

UNE-EN 12371:2011: Test methods for natural stone. Determination of frost resistance.

UNE-EN 12059:2008+A1:2012: Natural stone products. Massive stone. Requirements.

UNE-EN 14066:2014: Establishes the test method to determine the resistance of natural stone to weathering and environmental degradation.

UNE-EN 14157:2018: Test methods for natural stone. Determination of abrasion resistance.

UNE-EN 14579:2005: Test methods for natural stone: Determination of sound propagation velocity

UNE-EN 1926:2007: Test methods for natural stone. Determination of uniaxial compressive strength.

UNE-EN 1936:2007: Test methods for natural stone. Determination of real and apparent density and open and total porosity.

UNE 22190:2014: Natural stone products. Construction of sloping roofs and vertical wall cladding with slate.

3.3. Romania: detailed regulatory context on ornamental waste management

As an EU member state, Romania has adapted its waste legislation to comply with EU requirements through a set of regulations governing waste generation, classification, traceability, and disposal.

In the ornamental stone value chain (from quarrying to cutting and finishing), typical regulated flows include extracted materials (overburden and inert waste), stone cuttings, and fine fractions such as sludge or dust from processing. All such waste must be correctly classified and registered in the national waste management system.

The general framework is based on Ordonanța de Urgență a Guvernului nr. 92/2021 on the waste regime, which establishes the obligations of waste generators in terms of prevention, separate collection, and traceability, aligning with the EU Waste Framework Directive.

In addition to this general framework, there is a specific regime for waste from extractive industries, which directly affects the quarrying sector.

3.3.1. National Legislation

Government Emergency Ordinance No. 92/2021 — on waste management

General framework regulating prevention, separation, traceability, and obligations of waste producers, in line with European legislation.

pwc.ro

Law No. 17/2023 — approving Emergency Ordinance No. 92/2021

Law approving and supplementing the above regulation, reinforcing the transposition of European directives on the circular economy.

Government Ordinance No. 2/2021 — on waste landfills

Regulates strict conditions and controls for waste disposal, being particularly relevant for inert waste that cannot be recovered.

Government Decision No. 856/2008 — waste management in extractive industries

Transposes the EU Mining Waste Directive into Romanian law, requiring extractive waste management plans and establishing safety requirements for waste facilities in quarries.

Government Decision No. 856/2002 — waste management registers

Approves the national waste list and coding standards; all stone waste must bear an appropriate code.

Ordinul nr. 95/2005 — criteria for accepting waste in landfills

Sets technical criteria and preliminary procedures for accepting waste in landfills, including test limits for inert waste. (Regulatory reference)

Law on Mining No. 85/2003 — Framework for mining and extraction

Regulates mining and quarrying activities, establishing environmental obligations related to site closure and rehabilitation. (Regulatory reference)

Emergency Ordinance No. 195/2005 — Environmental Protection

Framework law underpinning permitting requirements and environmental compliance in Romania. (Regulatory reference)

3.3.2. Related SR EN / EN Standards

Romania adopts European standards (EN) as national standards under the designation SR EN through ASRO (Asociația de Standardizare din România). These standards serve as the technical basis for verifying the performance and properties of natural stone products on the market or for their possible reuse:

SR EN 1467: Natural stone. Rough blocks. Requirements.

SR EN 1468: Natural stone. Rough slabs. Requirements.

SR EN 1469: Natural stone products. Slabs for cladding. Requirements.

SR EN 12057: Natural stone products. Modular tiles. Requirements.

SR EN 12058: Natural stone products. Slabs for floors and stairs. Requirements.

SR EN 1341: Slabs of natural stone for external paving. Requirements and test methods.

SR EN 1342: Setts of natural stone for external paving. Requirements and test methods.

SR EN 1343: Kerbs of natural stone for external paving. Requirements and test methods.

SR EN 771-6: Specification for masonry units. Part 6: Natural stone masonry units.

SR EN 12440: Natural stone. Denomination criteria.

SR EN 1936: Natural stone test methods. Density and porosity.

SR EN 1925: Water absorption coefficient by capillarity.

SR EN 1926: Compressive strength.

SR EN 12371: Frost resistance.

SR EN 13755: Water absorption at atmospheric pressure.

SR EN 14157: Abrasion resistance.

SR EN 14231: Slip resistance (pendulum tester).

3.4. Croatia: detailed regulatory context on ornamental waste management

In Croatia, the ornamental stone value chain (from quarrying to processing) generates waste streams similar to those in other EU Member States: clearing material and inert mineral fractions from extraction, offcuts and non-commercial-size blocks, as well as sludge and fine dust from cutting, polishing, and water treatment systems. As an EU Member State, Croatia regulates this waste through a general waste framework supplemented by specific regulations and a special regime for extractive waste.

In practice, regulation for the sector focuses on several points: the correct classification of waste according to the National Waste List, permit and operating requirements for storage, treatment, and recovery, specific obligations that apply to waste from the extractive industry (including planning and risk control at waste facilities), and

acceptance criteria for landfills when recovery is not possible (Narodne novine, 2021; Narodne novine, 2022; Narodne novine, 2023a).

In addition, Croatia has strengthened traceability and reporting systems through national registries and electronic platforms that support the obligations established by the Waste Management Act, which is relevant for future digitization of compliance evidence (e.g., traceability of shipments, recovery operations, and end-of-waste criteria results) (ISGO, n.d.; Narodne novine, 2021).

3.4.1. Main regulations

Waste Management Act (Zakon o gospodarenju otpadom): Establishes the national waste hierarchy, responsibilities of waste holders, permitting principles, and compliance standards affecting quarries and stone plant operators (Narodne novine, 2021).

Ordinance on Waste Management (Pravilnik o gospodarenju otpadom**):** Develops operational requirements such as documentation, record keeping, and specific procedures, and includes the Waste List as a reference for classification, which is key for typical waste in the stone sector (Narodne novine, 2022; Narodne novine, 2024).

Ordinance on Landfills (Pravilnik o odlagalištima otpada): Sets criteria for landfill acceptance, operation and closure requirements, as well as pre-treatment conditions prior to disposal, applicable when there are no recovery routes for inert mineral waste (Narodne novine, 2023a).

Ordinance on Extractive Waste (Pravilnik o gospodarenju otpadom iz rudarske industrije): This is the specific regulation for quarry waste, establishing requirements for extractive waste management plans, preventive measures, safety management, permits, and supervision of extractive waste facilities (Narodne novine, 2023b).

Ordinance on Construction Waste and Asbestos-Containing Waste (Pravilnik o građevnom otpadu i otpadu koji sadrži azbest): Applies to the interface between mineral waste and recycled aggregates when they enter construction recovery circuits under controlled conditions (Narodne novine, 2016).

End-of-Waste Ordinance (Pravilnik o ukidanju statusa otpada): Defines criteria and procedures for determining when a material ceases to be waste, including provisions that may apply to recycled aggregates, which is useful in scenarios involving the recovery of processed mineral fractions (Narodne novine, 2023c).

Waste Management Plan of the Republic of Croatia 2023–2028 (Plan gospodarenja otpadom RH 2023–2028): Sets national priorities and objectives that guide implementation, investment, and monitoring, including the strategy to reduce dependence on landfills and increase recovery rates (Narodne novine, 2023c; Narodne novine, 2025).

3.4.2. Related HRN EN standards

As in other EU Member States, Croatia adopts European standards as national standards under the designation HRN EN, and the stone sector typically uses these harmonized specifications and test methods to evaluate the performance of natural stone products in construction applications (HZN, n.d.; CEN-CENELEC, n.d.; Donatello et al., 2018). Among the most relevant are:

HRN EN 1467: Natural stone. Rough blocks. Requirements.

HRN EN 1468: Natural stone. Rough slabs. Requirements.

HRN EN 1469: Natural stone products. Slabs for cladding. Requirements.

HRN EN 12057: Natural stone products. Modular tiles. Requirements.

HRN EN 12058: Natural stone products. Slabs for flooring and stairs. Requirements.

HRN EN 1341 / 1342 / 1343: Natural stone paving units: slabs, pavers, and kerbs. Requirements and test methods.

HRN EN 771-6: Specification for masonry units. Part 6: Natural stone units.

HRN EN 12440: Natural stone. Designation criteria.

HRN EN 1936: Test methods for natural stone. Actual density, apparent density, total and open porosity.

HRN EN 13755: Test methods for natural stone. Water absorption at atmospheric pressure.

HRN EN 12371: Test methods for natural stone. Resistance to frost.

HRN EN 14157: Test methods for natural stone. Abrasion resistance.

HRN EN 14231: Test methods for natural stone. Slip resistance according to pendulum test.

4. RESULTS AND GENERAL COMPARATIVE ANALYSIS

This section moves beyond what regulations say to what they actually mean for day-to-day operations in the ornamental stone sector. It focuses on three key regulatory moments that shape how waste is handled in quarries and processing plants:

- **Classification**: How residues are identified and documented.
- **Recovery Routes**: What legal options exist to reuse mineral waste, especially in construction.
- **Extraction Duties**: How rules for quarry waste and site closure are managed.

The goal is not to rank countries, but to highlight which frameworks support circular practices and where legal fragmentation or bureaucracy still push reusable stone waste toward landfill.

4.1. GERMANY

4.1.1. Regulatory backbone and circular-economy orientation

Germany stands out for having a solid, general legal structure that incorporates circular economy principles into daily operations. Instead of sector-specific rules for stone, the industry follows broader environmental laws—especially the **Circular Economy Act (KrWG),** which prioritize waste prevention, recovery, and proper classification across all waste types, including mineral residues

4.1.2. Turning Waste into Product: The EBV Framework

One of Germany's key advantages is the existence of clear, legal pathways that allow processed mineral waste to re-enter the economy. The **Substitute Building Materials Ordinance (Ersatzbaustoffverordnung - EBV)**, part of the recent *Mantelverordnung* package, sets national standards for when mineral residues, like stone offcuts or sludge, can be used in construction.

This includes strict quality and environmental criteria (e.g., pollutant thresholds to protect groundwater), offering legal certainty and reducing the risk of these materials being wrongly sent to landfill.

4.1.3. Emphasis on Documentation and Traceability

Germany requires detailed tracking of all waste movements. Through the **Ordinance on Waste Recovery and Disposal Records (NachwV)**, companies are used to maintaining digital records showing what type of waste was produced, how much, and where it went.

This makes Germany particularly well-suited to digital traceability tools like blockchain—one of RockChain's core innovations, because companies are already familiar with verifiable, auditable reporting.

4.1.4. Managing Extractive Waste from Start to Finish

For stone quarries, Germany applies specific legal obligations linked to the EU Mining Waste Directive. The **Extractive Waste Ordinance (GewinnungsAbfV)** and the **Federal Mining Act (BBergG)** ensure that waste management and site rehabilitation are planned from the start—not treated as afterthoughts. This approach helps avoid environmental risks and supports long-term resource efficiency.

4.1.5. Key Takeaways for Germany

- **Robust legal system**: Germany's general waste laws are strong, enforceable, and already cover the stone sector without needing special exemptions.
- **Clear path to circularity**: The EBV provides a national route to reuse clean stone residues as construction materials, offering legal and environmental clarity.
- **Digital readiness**: Traceability through documentation is already standard, making the transition to blockchain-based systems smoother.
- **SME challenge**: While the legal tools exist, small companies often struggle with the technical demands (e.g., lab testing, documentation) needed to take full advantage of reuse pathways.

4.2. SPAIN

4.2.1. National Framework with Regional Variability

Spain's regulatory setup combines a strong national framework with regional implementation, leading to considerable differences in how rules are applied across the country. At the national level, **Law 7/2022** enforces the EU waste hierarchy and clarifies duties related to prevention, traceability, and classification. It also defines when a material can lose its waste status or be treated as a by-product—crucial for deciding the fate of stone sludge or offcuts.

However, real-world enforcement falls to the Autonomous Communities, which issue permits, conduct inspections, and interpret legal thresholds. This decentralization creates practical barriers, especially for companies operating in multiple regions, as they face inconsistent documentation, treatment approvals, or shipment rules.

4.2.2. What Counts as Waste? Classification Is Everything

In Spain, proper classification determines whether a material is treated as recoverable or must be disposed of. The country follows the **European List of Waste (LoW)**, and each waste code has implications for how the material can be handled.

For stone producers, inert materials like gravel or offcuts are generally accepted in recovery pathways (e.g., for construction fill). But sludge and fine residues often fall into a grey area. Unless consistent quality can be proven, these materials remain in the "waste" category and require formal disposal, even when technically reusable. The complexity of achieving End-of-Waste status discourages many SMEs from pursuing reuse certifications.

4.2.3. Moving Waste: Digital Traceability and the eSIR System

Spain is advancing digitalization in waste management through **Royal Decree 553/2020**, which governs how waste is transported and tracked across the country. All shipments must be logged via **eSIR**, the national electronic platform that standardizes documentation between waste producers, carriers, and recipients.

This digital traceability has two effects:

- It improves transparency and ensures that waste flows are formally recorded.
- It increases pressure on accurate classification, since errors upstream can lead to rejections or fines downstream.

For the stone sector, this means that successful digital compliance depends not only on using the system—but on inputting consistent, trusted data. This creates a strategic entry point for RockChain to offer added value as a verification tool.

4.2.4. Extractive Waste Is Tied to the Mining Permit

Quarries fall under a specific legal regime governed by **Royal Decree 975/2009**, which transposes the EU Extractive Waste Directive. Here, waste isn't just a by-product—it's part of the license to extract. Operators must present **Extractive Waste Management Plans**, perform stability assessments, and commit to site rehabilitation as part of their permit obligations. This ensures that quarry waste is planned and monitored throughout the site's lifecycle, not managed as an afterthought.

4.2.5. Key Takeaways for Spain

- **Solid legislative structure**: Spain aligns well with EU law, with clear separation between general waste (Law 7/2022) and extractive waste (RD 975/2009).
- **Main bottleneck**: The challenge lies in regional inconsistency, particularly around End-of-Waste authorisations and procedural interpretation.
- **Digital strengths and gaps**: Spain's eSIR system shows how digital traceability can streamline operations, but only if the underlying data is reliable. This opens the door for RockChain to act as a trusted digital layer, reducing uncertainty and harmonizing classification across operators and regions.

4.3. ROMANIA

4.3.1. Regulatory Structure and Alignment with EU Circular Goals

Romania has overhauled its waste legislation in recent years to align with EU circular economy principles. The main legal foundation is **Government Emergency Ordinance (GEO) No. 92/2021**, amended by **Law No. 17/2023**, which integrates the waste hierarchy into standard operational duties. It sets clear responsibilities for waste prevention, classification, and traceability.

However, despite this modern legal structure, waste management outcomes remain inconsistent. EU reports highlight that Romania still relies heavily on landfill and struggles to develop scalable recovery systems. For the stone sector, this means that while the rules exist, practical reuse pathways remain limited by infrastructure and enforcement gaps.

4.3.2. Mineral Waste: The Gap Between Legal Possibility and Practice

Stone waste recovery is legally permitted under Romania's general waste framework, but there is no unified recovery path, unlike Germany's clearly defined EBV. Instead, each recovery case depends on:

- Local market demand for recycled aggregates.
- Permit conditions at individual receiving sites.
- Operator ability to document quality and compliance.

At the same time, landfill remains a fallback. **OG No. 2/2021** and **Order No. 95/2005** set strict criteria for landfill acceptance, making disposal more burdensome—but not necessarily making reuse easier. Without a harmonized system for declaring end-of-waste status, many operators lack the technical or administrative capacity to validate their materials for reuse.

4.3.3. Compliance Based on Documentation

Romania enforces compliance through a documentation-heavy approach. The **National Waste List (HG No. 856/2002)** mandates that every material stream must be properly classified and recorded. Without documentation, there is no legal recognition of treatment or transport.

The 2023 amendments (Law 17/2023) reinforce this approach, adding new obligations for tracking and verifying shipments. This policy shift supports transparency and begins to move the system away from informal practices. However, high landfill rates suggest that enforcement is still catching up with the regulatory ambition.

For the RockChain Project, this environment presents an opportunity: digital tools that simplify and automate record-keeping could directly respond to Romania's push for traceability.

4.3.4. Quarry Waste and Lifecycle Planning

When stone extraction is involved, Romania applies specific rules aligned with the **EU Extractive Waste Directive**. **HG No. 856/2008** governs extractive waste, requiring detailed waste management plans and safety monitoring. Combined with **Mining Law No. 85/2003**, these regulations ensure that quarry waste is treated as a structured part of site planning and closure—not as leftover material to be addressed later.

4.3.5. Key Takeaways for Romania

- **Legal alignment is strong**: GEO 92/2021 brings Romania in line with EU standards, but real-world application still lags behind.
- **Recovery remains fragmented**: There's no nationwide system for mineral reuse, each case depends on permits and local market conditions.
- **Traceability is emerging as a priority**: New rules are shifting focus toward transparency and shipment control, offering a good match for blockchain-based solutions.
- **Clear governance for quarry waste**: Romania's legal structure distinguishes between extractive and processing waste, with clear duties for site-level planning and rehabilitation.

4.4. CROATIA

4.4.1. Regulatory Structure and Oversight

Croatia manages the ornamental stone sector through a modern waste framework aligned with EU law. The **Waste Management Act** forms the legal core, setting the waste hierarchy and assigning clear responsibilities to waste producers and holders.

In practice, compliance is shaped by three main requirements:

- **Accurate classification**, using Croatia's version of the European List of Waste.
- **Strict permitting**, covering all storage, treatment, and recovery activities.
- **Controlled disposal**, where landfill is limited to residues that cannot be safely or feasibly reused.

For stone producers, this means that administrative obligations are high, and regulatory discipline is required at every stage of the material flow.

4.4.2. Recovery Options for Stone Waste

Croatia offers a structured path for mineral waste to be reused as a secondary material. This is governed by the **Ordinance on End-of-Waste**, which sets clear conditions under which residues, like crushed stone or sludge, can exit the waste regime and enter the construction market.

To qualify, operators must:

- Demonstrate product consistency through testing.
- Meet environmental safety criteria.
- Follow the **Ordinance on Construction Waste**, which governs how these materials can be safely used in new building works.

This legal clarity is a strong point: instead of relying on discretionary approvals, Croatia provides fixed criteria that operators can plan for.

4.4.3. Documentation and Digital Traceability

One of Croatia's standout features is its emphasis on digital reporting. Two systems underpin this:

- **e-ONTO**: The national Register of Waste Formation and Flow.
- **ISGO**: A broader platform for waste management governance.

These systems are mandatory for operators and already capture detailed data on waste classification, movement, and recovery.

For the RockChain Project, this is a key advantage. Croatian companies are used to digital compliance, making it easier to introduce blockchain-based traceability tools. The cultural and technical foundations are already in place.

4.4.4. Quarry Waste and Site-Level Duties

Stone extraction is subject to a specific legal regime through the **Ordinance on Extractive Waste**, which mirrors EU requirements. Quarry operators must:

- Prepare formal **Extractive Waste Management Plans**.
- Conduct risk assessments for storage and safety.
- Integrate waste planning into site operations and closure strategies.

This system ensures that extractive waste is treated separately from downstream residues and follows tailored procedures appropriate to its volume and environmental risk.

4.4.5. Key Takeaways for Croatia

- **Strong EU alignment**: Croatia's legal framework is current, comprehensive, and fully in line with European policy.
- **Clear rules for recovery**: The End-of-Waste Ordinance offers transparency and predictability for operators seeking to valorise stone waste.
- **Digitally advanced**: Existing national platforms like e-ONTO and ISGO mean traceability systems are already part of business-as-usual for most operators.
- **Effective separation of regimes**: Quarry waste and processing residues are governed by distinct but complementary rules, improving regulatory clarity.

5. OPPORTUNITIES FOR REGULATORY HARMONIZATION AND STANDARDIZATION

The comparative analysis of Germany, Spain, Romania, and Croatia confirms that the legal architecture is consistent at the European level, primarily structured around the Waste Framework Directive (2008/98/EC). However, the practical implementation of these rules shows significant divergences, especially in how countries interpret, classify, and manage ornamental stone residues.

Rather than lacking rules, the challenge lies in *how the same rules are applied differently*. This fragmentation creates legal uncertainty for operators and hinders the cross-border circulation of secondary materials.

Four harmonization priorities emerge from the study, as follow.

5.1. Harmonising "End-of-Waste" Criteria for Stone Residues

There is currently no EU-wide benchmark for when stone waste becomes a usable product. Some countries (like Germany and Croatia) offer clear regulatory pathways, while others depend on slow, case-specific approvals.

Opportunity: Define a shared technical and environmental evidence package for when mineral residues, such as sawing sludge or offcuts, can be recognized as recycled products.

Impact: This would create trust across Member States and reduce landfill dependence, unlocking markets for recycled aggregates in construction.

5.2. Consistent Use of Waste Codes (LoW)

Although all Member States use the European List of Waste, inconsistent application remains a barrier. Identical materials may receive different codes (e.g., inert sludge vs. contaminated waste), leading to different documentation, transport rules, and recovery options.

Opportunity: Develop sector-specific coding guidance for ornamental stone, ideally supported by test-based thresholds for distinguishing "clean" vs. "hazardous" sludge.

Impact: Reduces legal ambiguity and supports smoother national and cross-border logistics.

5.3. Interoperability of Waste Shipment Data

Digital traceability is advancing unevenly. Germany and Croatia have mature systems; Spain and Romania are mid-transition. However, these systems often require different data fields, formats, or document flows.

Opportunity: Harmonize the data structure for stone waste shipments—establishing a shared baseline (e.g., Batch ID, origin, composition, classification) across all platforms.

Impact: Improves traceability, reduces administrative friction, and prepares the ground for future digital tools and cross-border trade in secondary materials.

5.4. Clarifying the Boundary Between Extractive and General Waste

Stone residues frequently move between extractive (quarry) and industrial (processing) phases. But unclear transition rules cause overlaps in compliance obligations.

Opportunity: Define a common EU-level "handover point", when does a mineral by-product stop being extractive waste and become a product or general waste?

Impact: Simplifies compliance, especially for vertically integrated SMEs operating both extraction and transformation phases.

6. GENERAL CONCLUSIONS

This comparative study confirms that while the European Union provides a common legal foundation for waste management, through instruments like the Waste Framework Directive, the application of these rules to the ornamental stone sector remains fragmented. Although Member States share the same legal definitions for concepts such as waste, recovery, and disposal, the real-world treatment of stone residues still depends largely on how national authorities classify materials, interpret recovery criteria, and manage traceability.

Germany illustrates how a clear and mature regulatory system can enable circular practices, offering structured pathways for mineral residues to re-enter the economy. Spain, despite having a well-developed legislative framework, faces obstacles in implementation due to administrative differences between its regions. Romania and Croatia, meanwhile, are in a phase of transition: their laws reflect EU standards, but consistent enforcement and market uptake of secondary materials remain a work in progress.

What becomes clear from this analysis is that the core challenge is not the absence of regulation, but rather the uncertainty surrounding its practical application. When operators cannot predict how a residue will be classified, whether it qualifies as a product, or what evidence is needed for recovery, they tend to default landfilling, even when more sustainable options exist.

This uncertainty creates avoidable barriers to circularity. If the sector is to scale up the reuse of stone by-products across borders, what's needed is not more legislation, but clearer, harmonised interpretations of the rules already in place. Establishing shared technical benchmarks for classification, quality testing, and end-of-waste status would give companies the legal confidence to invest in recovery operations, knowing that the same criteria will apply regardless of location.

As the EU moves toward full digitalisation of waste traceability, aligning the underlying data requirements becomes just as important. Systems like Germany's NachwV, Spain's eSIR, and Croatia's e-ONTO are valuable steps forward, but only if the information they manage is compatible across borders.

In this landscape, the RockChain project has a strategic role to play, not as a technology provider, but as a bridge between regulation and implementation. Its contribution should lie in helping professionals translate legal obligations into reliable documentation practices. The focus must shift from abstract regulatory knowledge to the practical ability to generate verifiable evidence (clear classification, batch identification, and laboratory validation) that meets harmonised standards. In this context, tools like blockchain may serve as a useful layer of trust and traceability, but only insofar as they

support this core objective: making compliance transparent, transferable, and auditable across the European stone value chain.

7. REFERENCIAS

Commission Decision 2014/955/EU of 18 December 2014 amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC. (2014). *Official Journal of the European Union.* https://eur-lex.europa.eu/eli/dec/2014/955/oj/eng

Commission Implementing Regulation (EU) 2025/1290 of 26 June 2025 laying down rules for the interoperability of systems for electronic submission and exchange of information and documents under Regulation (EU) 2024/1157. (2025). *Official Journal of the European Union.* https://eur-lex.europa.eu/eli/reg_impl/2025/1290/oj

Council Decision 2003/33/EC of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Directive 1999/31/EC. (2003). *Official Journal of the European Union.* https://eur-lex.europa.eu/eli/dec/2003/33(1)/oj/eng

Council of the European Union. (1999). Council Directive 1999/31/EC on the landfill of waste. https://eur-lex.europa.eu/eli/dir/1999/31/oj/eng

Delgado, L., Catarino, A. S., Eder, P., Litten, D., Luo, Z., & Villanueva, A. (2009). *End-of-waste criteria: Final report* (JRC Scientific and Technical Reports). Publications Office of the European Union. https://publications.jrc.ec.europa.eu/repository/handle/JRC53238

Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries. (2006). *Official Journal of the European Union.* https://eur-lex.europa.eu/eli/dir/2006/21/oj/eng

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. (2008). *Official Journal of the European Union.* https://eur-lex.europa.eu/eli/dir/2008/98/oj/eng

Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31/EC on the landfill of waste. (2018). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0850

Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste. (2018). https://eur-lex.europa.eu/eli/dir/2018/851/oj/eng

EU Blockchain Observatory and Forum. (2024). *Digital Product Passports: A blockchain-based perspective* (Report). European Commission. https://blockchain-observatory.ec.europa.eu/document/download/b6e3c85c-43c1-405b-aba8-e49a71249ef7_en

European Commission. (2012). *Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste.* https://ec.europa.eu/environment/waste/framework/pdf/guidance_doc.pdf

European Commission. (2018). *Commission notice on technical guidance on the classification of waste* (2018/C 124/01). *Official Journal of the European Union, C 124.* https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:C:2018:124:FULL

European Commission. (2019). *The European Green Deal* (COM(2019) 640 final). https://www.consilium.europa.eu/media/39516/european-green-deal-st15051-en19.pdf

European Commission. (2020). *A new Circular Economy Action Plan: For a cleaner and more competitive Europe* (COM(2020) 98 final). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0098

European Commission. (2020). *Study on Member States practices on by-products and end-of-waste: Final report.* https://images.chemycal.com/Media/Files/KH0420276ENN.en.pdf

European Commission. (2021). Commission Decision (EU) 2021/476 establishing the EU Ecolabel criteria for hard covering products. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021D0476

European Commission. (2022). *EBSI — Document traceability use case (overview).* https://ec.europa.eu/digital-building-blocks/sites/display/EBSI/Use+Cases

European Commission. (2024). *European Union legislation on waste management* (Summaries of EU legislation). https://eur-lex.europa.eu/ES/legal-content/summary/eu-waste-management-law.html

European Commission. (2025, July 2). *Commission adopts key legal act to digitalise EU waste shipments.* https://environment.ec.europa.eu/news/commission-adopts-key-legal-act-digitalise-eu-waste-shipments-2025-07-02_en

European Commission. (n.d.). *Implementation of the Waste Shipment Regulation (digitalisation / DIWASS).* https://environment.ec.europa.eu/topics/waste-and-recycling/waste-shipments/implementation-waste-shipment-regulation_en

European Environment Agency (EEA). (n.d.). *Resource efficiency and waste.* https://www.eea.europa.eu/es/themes/waste/intro

European Environment Agency (EEA). (2022). *Germany – country fact sheet / waste management profile.* https://www.eea.europa.eu/publications/many-eu-member-states/germany

Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products. (2011). https://eur-lex.europa.eu/eli/reg/2011/305/oj/eng

Regulation (EU) 2020/1056 of the European Parliament and of the Council of 15 July 2020 on electronic freight transport information. (2020). *Official Journal of the European Union.* https://eur-lex.europa.eu/eli/reg/2020/1056/oj/eng

Regulation (EU) 2024/1157 of the European Parliament and of the Council of 11 April 2024 on shipments of waste. (2024). *Official Journal of the European Union.* https://eur-lex.europa.eu/resource.html?uri=OJ:L_202401157&format=PDF

Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products. (2024). https://eur-lex.europa.eu/eli/reg/2024/1781/oj/eng