BLOCKSTAND

D2.5 Standardisation Gaps & Recommendations' Atlas

JULY 2024

Funded by
the European Union

Deliverable Information

Project Acronym	BlockStand
Project Name	Empowering European Experts' leadership in Blockchain Standardisation
Grant Agreement number	101102757
Document full Number	BlockStand_D2.5_Standardisation_Gaps_&_Recommendations_Atlas_INATBA_v1.5_20240823.pdf
Deliverable Title	D2.5 Standardisation Gaps & Recommendations' Atlas
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Contributor(s) if any	UNINFO
Dissemination level	Public

Document Version History:

Version	Date	Author	Description of the change
V1.1	27 May 2024	Ricardo Simoes (INATBA), Bara Greplova (INATBA), Serena Dell'Agli (Digital SME), Andrea Raffaelli (SBS), Gabriele Casalini (Digital SME), Justina Bieliauskaite (Digital SME), Andreea Mihaela David (SBS)	Working document
V1.2	31 July 2024	Ricardo Simoes (INATBA), Bara Greplova (INATBA), Serena Dell'Agli (Digital SME), Andrea Raffaelli (SBS), Gabriele Casalini (Digital SME), Justina Bieliauskaite (Digital SME)	Final draft
V1.3	1August 2024	Ricardo Simoes (INATBA), Bara Greplova (INATBA), Serena Dell'Agli (Digital SME), Andrea Raffaelli (SBS), Gabriele Casalini (Digital SME), Justina Bieliauskaite (Digital SME)	Adjustments, after review
V1.4	14 August 2024	Ricardo Simoes (INATBA), Bara Greplova (INATBA), Serena Dell'Agli (Digital SME), Andrea Raffaelli (SBS), Gabriele Casalini (Digital SME), Justina Bieliauskaite (Digital SME)	Further adjustments, after second review
V1.5	23 August 2024	Ricardo Simoes (INATBA), Bara Greplova (INATBA), Serena Dell'Agli (Digital SME), Andrea Raffaelli (SBS), Gabriele Casalini (Digital SME), Justina Bieliauskaite (Digital SME)	Final adjustments, after third review

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GLOSSARY

Acronym	Explanation
BCI	Blockchain & Climate Institute
CEN-CENELEC	European Committee for Standardisation & European Committee for Electrotechnical Standardisation
DG CONNECT	European Commission Directorate-General for Communications Networks, Content and Technology
DG DIGIT	European Commission Directorate-General for Informatics
DG GROW	European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
DIH	Digital Innovation Hub
DLT	Distributed Ledger Technology
DoA	Description of Action
DSME	European DIGITAL SME Alliance
EBP	European Blockchain Partnership
EBSI	European Blockchain Services Infrastructure
EBSI-NE	EBSI National Nodes and Entities
EDIC	European Digital Infrastructure Consortium
EMB	Executive Management Board
ETSI ISG PDL	European Telecommunications Standards Institute Industry Specification Group on Permissioned Distributed Ledgers
EU	European Union
EUBOF	EU Blockchain Observatory and Forum
GDPR	General Data Protection Regulation
ICT	Information and Communication Technology

INATBA	International Association for Trusted Blockchain Applications
ISO	International Organisation for Standardisation
JADES	Joint Algorithm for Digital Signatures
KPI	Key Performance Indicator
NBA	Nordic Blockchain Association
PR	Press Release
R&I	Research and Innovation
SBS	Small Business Standards
SDO	Standards Developing Organisation
SME	Small and Medium Enterprise
TC	Technical Committee
TCB	Technical Coordination Board
VC	Verifiable Credential
VET	Vocational Education and Training
WG	Working Group
WP	Working Package

LIST OF FIGURES

EXECUTIVE SUMMARY

The "Standardisation Gaps & Recommendations' Atlas" is based on BlockStand's ongoing tasks of Mapping Ongoing Blockchain Standardisation Activities (T2.1), the analysis of the Blockchain Standardisation Needs & Recommendations focusing on the European Blockchain Services Infrastructure (EBSI), (T2.2), the Research & Innovation Community (R&I), (T2.3), and small and medium enterprises (SMEs), (T2.4), as well as on the Online Repository of Blockchain Standardisation Activities.

This deliverable provides an overview of all these findings. It outlines the gaps and mismatches identified and provides policy and standardisation recommendations, reflecting the needs of the three groups of key stakeholders.

The Atlas serves as a critical tool in the BlockStand project, identifying current gaps in blockchain standardisation and offering strategic recommendations to address these deficiencies. This ensures that European blockchain standards are comprehensive, effective, and aligned with the needs of key stakeholders, including EBSI, the R&I community, and SMEs.

The methodology employed in the creation of the "Standardisation Gaps & Recommendations' Atlas" is multifaceted, combining various data collection and analysis techniques to ensure comprehensive and accurate identification of standardisation gaps and the development of strategic recommendations. This includes a detailed questionnaire distributed to stakeholders, extensive standards repository reviews, regular stakeholder meetings, in-depth interviews with representatives from relevant research and innovation projects, and workshops with SMEs. The collected data from these activities were systematically analysed to identify common themes and gaps, informing the development of targeted recommendations aimed at addressing the identified standardisation needs.

For the sake of this report, Distributed Ledger Technology (DLT) and Blockchain terms are used interchangeably with the same significance.

Key Findings and Recommendations

1. EBSI Stakeholders:

- Identified Needs: The roles of EBSI stakeholders are diverse, including trusted verifiers, issuers of verifiable credentials, and digital wallet providers. The need for enhanced traceability, improved security measures, and trusted data sharing services was highlighted.
- Recommendations: Collaborative efforts with EBSI National Nodes and Entities (EBSI-NE) are essential for regional relevance and synergy. Engaging domain experts and stakeholders will ensure that standards are well-informed and reflective of the latest advancements and challenges.

2. R&I Community:

- Identified Needs: The R&I community plays a crucial role in shaping blockchain standards through cutting-edge research and innovation. Challenges include a shortage of skilled personnel and the rapid pace of technological change.

- Recommendations: Increase funding for research and development, establish cross-industry and cross-sector standards, and provide comprehensive training programs to enhance expertise in blockchain standardisation. Additionally, recommendations for specific standardisation priorities that should be explored further in the coming months are also included.

3. SMEs:

- Identified Needs: SMEs face challenges in adopting blockchain technology due to its complexity and the lack of clear, practical demonstrations of its benefits. Issues like interoperability, technical implementation, and regulatory compliance were noted.
- Recommendations: Develop industry-specific standards, provide financial support and incentives, and offer targeted training programs and resources to facilitate SMEs' participation in blockchain standardisation.

As additional recommendations and to enhance the effectiveness of blockchain technology, particularly at the EU level, a couple of key recommendations are proposed. Notable recommendations include: Firstly, improving coordination between different actors and projects is essential. This includes fostering more dialogue between research, policy, industry, and standardisation bodies to ensure a cohesive and integrated approach. Secondly, fostering the legal and social acceptance of blockchain technology through practical use-cases, awareness-raising initiatives, and inclusion in the regulatory framework is crucial. Standards play a vital role in this process by addressing security issues, enhancing trust and interoperability, and providing concrete use-cases that demonstrate the technology's benefits and reliability. Standardisation areas that should be prioritised include European Digital Identity / EU Digital Identity Wallet, Verifiable Credential for eSignature/eSeal, and Smart Contracts.

The international blockchain and DLT standardisation landscape is crucial for ensuring global interoperability and collaboration across various applications and sectors. The BlockStand project, through its support and coordination of EU standardisation experts aims to enhance European leadership in blockchain standardisation, ensuring that the standards developed are robust, inclusive, and aligned with the strategic goals of the European Union. Outputs like the “Standardisation Gaps & Recommendations' Atlas”, and others produced by BlockStand, are cornerstone references to leverage those goals.

By addressing current gaps and mismatches, implementing targeted recommendations, and staying attuned to emerging trends, the EU can foster a robust, interoperable, and secure blockchain ecosystem that supports innovation and economic growth for the internal market.

1 INTRODUCTION

1.1 BlockStand Project: Boosting EU Experts' Leadership in Blockchain Standardisation

BlockStand is an EU-funded project designed to enhance European leadership in the global blockchain standardisation landscape. It aims to ensure that blockchain standards used internationally reflect European values and priorities. Launched with the support of the Digital Europe Programme, BlockStand facilitates the participation of European experts in blockchain and Distributed Ledger Technology (DLT) standardisation activities.

BlockStand's primary goals are:

- to support the implementation of the European Commission's Rolling Plan for ICT Standardisation in the blockchain sector;
- to strengthen connections with EBSI and the European Blockchain Partnership (EBP);
- to enhance the participation of European experts in international and European Standards Developing Organisations.

The project is steered by an Executive Management Board composed of high-level representatives from industry, public institutions, and academia. It also features a Technical Coordination Board that coordinates and supports the work of blockchain standardisation experts.

BlockStand's main public interface is the Blockchain Standardisation Facility, which is a web-based one-stop platform where stakeholders can access all resources related to blockchain standardisation and interact with one another. It includes:

- Information on the Executive Management Board, the Body that steers the project, and the Technical Coordination Board that supports the work of the experts;
- Information on the Experts' selection process;
- Report on Blockchain inclusion to the Rolling Plan;
- European Blockchain Standardisation Roadmap;
- Experts' Success Stories Europe's Blockchain Leadership Outlook;
- Standardisation Gaps and Recommendations' Atlas;
- Repository of standardisation initiatives;
- Stakeholder forum;
- Reports from BlockStand Standardisation Experts.

As a direct outcome of the mapping efforts of the project, the Online Repository of Blockchain Standardisation Activities was created as the main hub to provide a comprehensive and detailed overview of past and ongoing standards related to Blockchain & DLT. It also includes a list of Technical Committees from the Standards Developing Organisations to which experts could

apply within the scope of the project, thus contributing to foster European leadership in blockchain standardisation. Within the Repository webpage, users can interact with around 100 blockchain standards activities within the catalogue, which is freely accessible to the interested users and is kept regularly updated.

1.1.1 BlockStand Partners

Four partners with extensive experience in blockchain standardisation manage BlockStand's consortium. They work together to ensure the project's success and support Europe's strategic autonomy in the blockchain domain.

- The **European DIGITAL SME Alliance (DIGITAL SME)** is the largest network of ICT sector SMEs in Europe, connecting over 45,000 businesses and comprising 30 national and regional SME associations. It advocates for digital SMEs in EU policy and participates in key technical committees, achieving significant strategic gains in digitalisation.
- The **International Association for Trusted Blockchain Applications (INATBA)**, established in 2019 with support from the European Commission, champions the widespread adoption of blockchain and DLT positive and responsible solutions and applications globally.
- **Small Business Standards (SBS)** is a non-profit European association funded by the EU and EFTA states, aimed at representing SMEs in the standardisation process at European and international levels. As an active participant in European Commission initiatives like the High-Level Forum on Standardisation, SBS advocates for SME interests in various standard-setting contexts.
- **UNINFO**, an associated body of UNI (the Italian national standardisation body), focuses on Information Technologies, including IoT, IT security, electronic identity, and e-business. It plays a leading role in blockchain standardisation as part of CEN-CENELEC's JTC19, which is dedicated to blockchain and DLT standardisation activities.

1.1.2 BlockStand Stakeholders Map

BlockStand has identified five primary groups and their main stakeholders. The identified stakeholder groups represent a diverse array of entities, from policy-making bodies and industry associations to standardisation committees and research institutions.

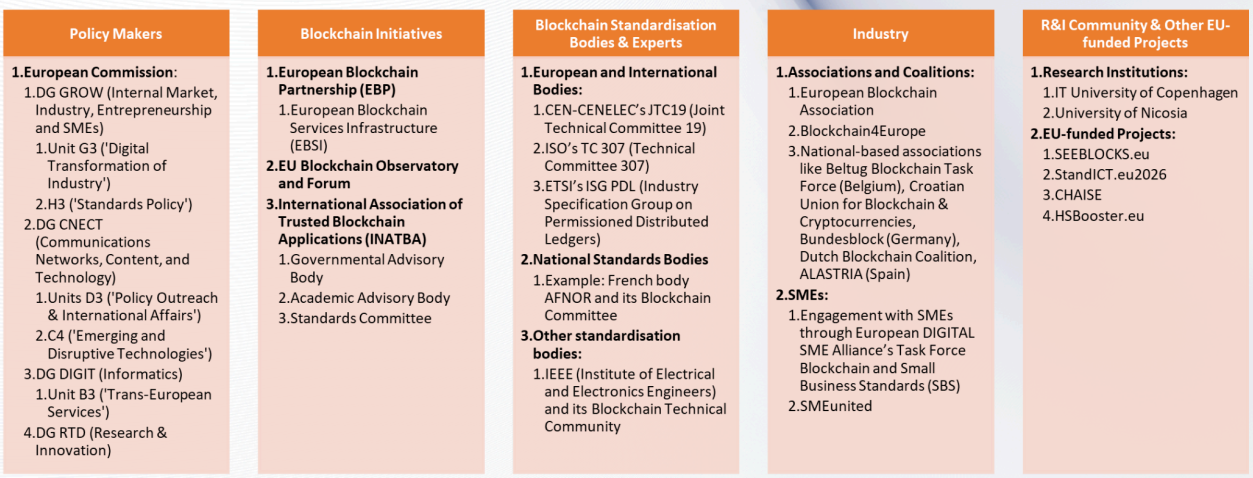

Figure 1: BlockStand Stakeholders Map.

This detailed stakeholder mapping allows BlockStand to steer its activity, engagement and communication efforts strategically. Understanding the unique characteristics and needs of each group ensures that the project's interactions are both effective and meaningful, enhancing the overall impact of the European blockchain standardisation efforts.

1.2 Standardisation Gaps & Recommendations' Atlas: Purpose & Structure

The "Standardisation Gaps & Recommendations' Atlas" serves a crucial role in the BlockStand project by identifying existing gaps in blockchain standardisation and providing strategic recommendations to address these deficiencies. Its primary purpose is to ensure that European blockchain standards are comprehensive, effective, and aligned with the needs of key stakeholders, including EBSI, the R&I community, and SMEs.

1.2.1 Purpose

- **Identification of Gaps**: The Atlas meticulously maps out the current landscape of blockchain standardisation, highlighting areas where existing standards are insufficient or lacking entirely. This is vital for ensuring that the development of blockchain technology in Europe remains robust and forward-looking.
- **Strategic Recommendations**: Based on the identified gaps, the Atlas offers detailed recommendations aimed at enhancing the standardisation landscape. These recommendations are designed to support policy-makers and SDOs in the seamless integration and widespread adoption of blockchain technologies across various sectors.

1.2.2 Structure

- **Blockchain Standardisation Mapping**: This section provides an overview of existing blockchain standards and frameworks, setting the stage for identifying gaps.
- **Needs and Recommendations by Stakeholder Groups**: The Atlas is structured to address the specific standardisation needs of different stakeholder groups:
    - **EBSI**: Examines the role and objectives of EBSI, its contributions to the European blockchain standardisation landscape, and the specific gaps and needs for implementing blockchain solutions within EBSI.
    - **R&I Community**: Focuses on the role of the research and innovation community in blockchain standardisation, identifying gaps, and proposing policy and standardisation recommendations to support their efforts.
    - **SMEs**: Discusses the role of SMEs in blockchain standardisation, the challenges they face in adopting blockchain technologies, and recommendations to facilitate their involvement and address their unique needs.
- **Policy & Standardisation Recommendations**: This section consolidates the insights from the various stakeholder groups, providing comprehensive recommendations to address the identified gaps and enhance the overall blockchain standardisation framework in Europe.

The Atlas is an essential tool for guiding the evolution of blockchain standards, ensuring they meet the diverse needs of all stakeholders and support the strategic goals of the European Union.

1.3 Overview of the Methodology Used

The methodology employed in the creation of the "Standardisation Gaps & Recommendations' Atlas" is multifaceted, aiming for a comprehensive and accurate identification of standardisation gaps and the development of strategic recommendations. This methodology combines various data collection and analysis techniques, conducted by all partners of the BlockStand consortium, to capture a wide range of perspectives and insights from key stakeholders involved in blockchain and DLT standardisation.

Questionnaire

A detailed questionnaire designed and distributed by BlockStand was the primary data collection tool. This questionnaire targeted a diverse group of stakeholders, including industry professionals, academic researchers, policymakers, and standardisation experts. The responses provided valuable insights into the current state of blockchain standards, highlighting perceived gaps and areas needing improvement.

Repository of Blockchain Standardisation Initiatives

The project utilised the extensive repository of blockchain standardisation initiatives available at BlockStand's online facility and updated on a regular basis. This repository offers a comprehensive overview of existing standards and ongoing initiatives, serving as a crucial reference point for identifying where standards are lacking or need enhancement.

Meetings with Key Stakeholders

Regular meetings were conducted with representatives from EBSI, including European Commission DG Digit, responsible for developing EBSI, and DG Connect, which supervises the project. These meetings facilitated direct communication and collaboration, ensuring that the Atlas reflects the practical needs and strategic objectives of major EU blockchain initiatives.

Interviews with representatives from the R&I community

In-depth interviews were carried out with representatives from the R&I community focused on blockchain and DLT. These interviews provided critical insights into the challenges and needs faced by them, informing the recommendations within the Atlas.

A Workshop with SMEs

A workshop was organised with SMEs to discuss their use cases and experiences with blockchain technologies. "Boosting SME participation in blockchain standardisation" in November 2023 highlighted the unique challenges SMEs face in adopting and implementing blockchain solutions, contributing to a better understanding of their specific standardisation needs.

Data Analysis

The collected data from the questionnaire, repository reviews, meetings, interviews, and workshops were systematically analysed to identify common themes and gaps. This analysis informed the development of targeted recommendations aimed at addressing the identified standardisation needs.

By integrating these diverse inputs, the "Standardisation Gaps & Recommendations' Atlas" provides a thorough and nuanced understanding of the current landscape of blockchain standards, ensuring that the recommendations are well-informed and broadly applicable to various stakeholders within the European blockchain ecosystem.

2 BLOCKCHAIN STANDARDISATION MAPPING AND NEEDS

2.1 Existing Blockchain Standards and Frameworks

Blockchain technology and DLT have witnessed significant advancements and growing adoption across various sectors. To ensure interoperability, security, and standardised practices, several standards and frameworks have been established by leading organisations. Some of these publications were released as early as 2019, while others are still under development. This chapter delves into the landscape of these standards, highlighting key publications and their areas of focus.

2.1.1 Published Standards Overview

Issuing Organisations

To date, there are 46 main published standards specifically related to blockchain that have been identified and collected under the BlockStand Repository. These standards have been developed by various international organisations to cater to various aspects of blockchain technology:

- IEEE (Institute of Electrical and Electronics Engineers): 40 publications.
- ISO (International Organization for Standardisation): 5 publications.
- CEN-CENELEC (European Committee for Standardisation and European Committee for Electrotechnical Standardisation): 1 publication.

Areas of Application

The 46 blockchain standards cover a wide range of applications and technologies. Below is a breakdown of these publications by their areas of focus:

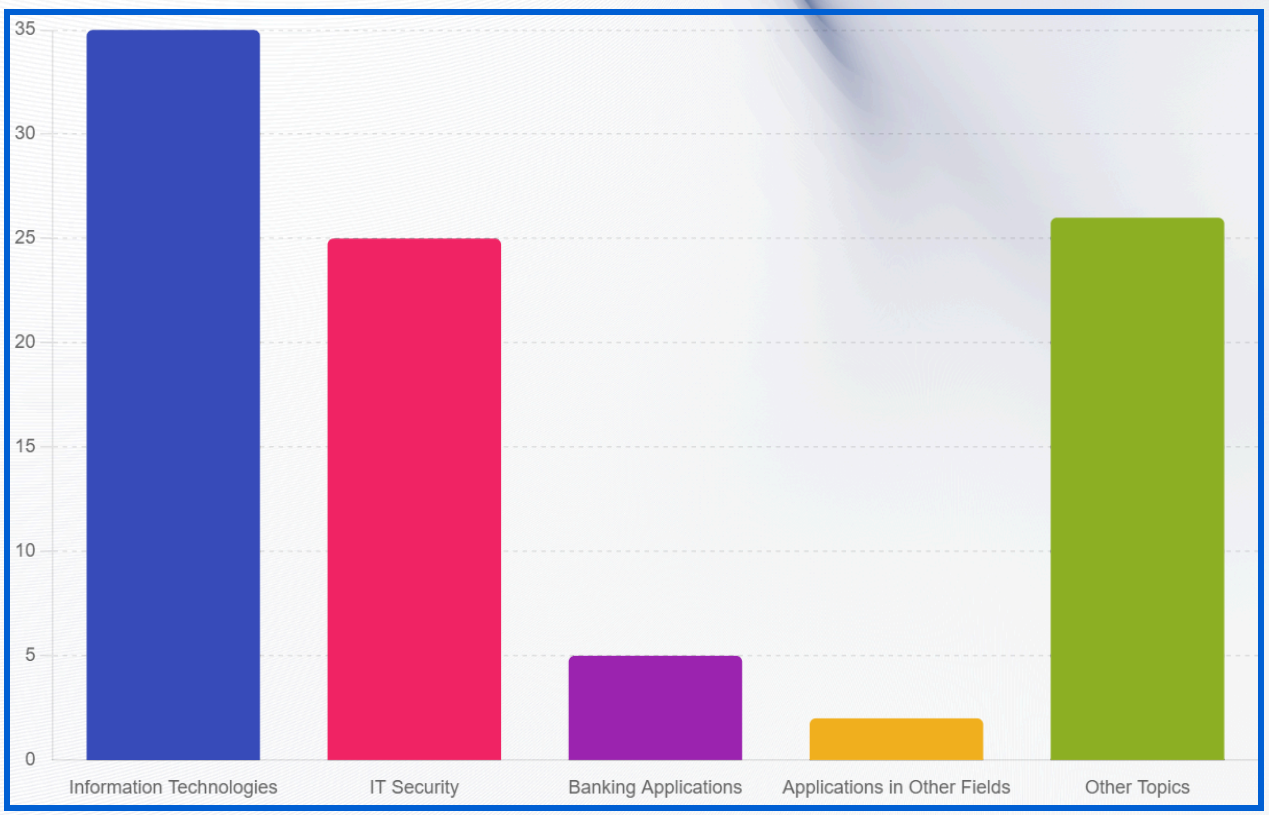

Figure 2: Breakdown of published blockchain standards by area of focus.

2.1.2 Additional Reports and Specifications

Beyond the published standards, other crucial documents contribute to the understanding and implementation of blockchain and DLT.

Technical Reports

There are 16 Technical Reports that provide in-depth analyses, findings, and recommendations related to blockchain and DLT. These reports often serve as valuable resources for stakeholders looking to understand the technical intricacies and potential implications of adopting blockchain technology.

Group Specifications and Reports

The European Telecommunications Standards Institute (ETSI) has produced 26 Group Specifications or Group Reports applicable to its Specification groups. These documents offer guidelines and specifications pertinent to the telecommunications industry and its integration with blockchain technology.

Technical Specifications

In addition to the standards and reports, there are 9 Technical Specifications related to blockchain or DLT. These specifications provide detailed technical requirements and criteria that must be met for blockchain systems, ensuring consistency and interoperability across different implementations.

2.2 BlockStand Questionnaire on Standardisation Needs & Recommendations: Purpose & Structure

The BlockStand questionnaire was designed to identify the standardisation needs and recommendations within the blockchain community. It included segments targeted at all the stakeholders as well as sections tailored for the particular stakeholder groups. The aim was to understand the current landscape of blockchain technology adoption, involvement, and standardisation awareness among various organisations. The questionnaire was extensively disseminated through BlockStand's social media channels and by partners individually through their networks.

The questionnaire gathered responses from 47 participants – including 35 complete and 12 partial submissions – and was structured into five sections:

1. General Information;
2. Blockchain adoption, involvement and experience;
3. Awareness and involvement in Blockchain standardisation;
4. Needs and recommendations for Blockchain standardisation;
5. Additional comments.

The results reveal a broad range of organisational types participating in the questionnaire. Enterprises represented the majority of respondents at 42.55%, followed by research and innovation institutions or universities and other entities such as ICT startups and NGOs, each at 14.89%. Educational institutions and public bodies comprised smaller proportions, at 12.77% and 6.38%, respectively, while sectoral or industrial associations and national or EU partnerships were less represented.

In terms of enterprise size, the majority of respondents were from micro enterprises (55%), with smaller percentages from small (35%), medium (5%), and large enterprises (5%). Regarding their organisational scope, national organisations were predominant (55%), followed by international (25%), European (15%), and regional entities (5%).

The prevalent sector of activity among respondents was digital, at 53.19%, with other sectors including cybersecurity, education, and fintech making up 42.55%. Tourism and construction were less represented.

2.3 Questionnaire's Targeted Stakeholder Groups

The feedback gathered highlights several key stakeholder groups crucial to the development and standardisation of blockchain technology.

SMEs are essential as they often face challenges in understanding and leveraging blockchain technology due to its complexity and the lack of clear, practical demonstrations of its benefits.

R&I entities play a pivotal role in advancing the field through cutting-edge research and the development of new solutions, driving the technological progress necessary for the adoption and integration of blockchain. Both groups are integral in bridging the gap between theoretical advancements and practical applications.

Additionally, EBSI stakeholders are vital for ensuring that blockchain standards align with European regulatory frameworks and meet the needs of diverse users across the EU. Their involvement ensures that the infrastructure remains robust, secure, and interoperable. Engaging these stakeholders helps facilitate the creation of standardised solutions that are both effective and adaptable to evolving technological and regulatory landscapes.

2.4 Other Blockchain Standardisation Mapping Activities

Recent advancements in DLT standardisation have been comprehensively summarised by several key organisations:

- **ITU Telecommunication standardisation Sector (ITU-T, 2019)**: ITU-T's report from 2019 reflects the initial strides in DLT standardisation, focusing on foundational principles and early guidelines that set the stage for further development.
- **European Telecommunications Standards Institute (ETSI, 2020)**: ETSI's update in 2020 demonstrates a growing depth in the standards related to DLT, including more refined guidelines and frameworks tailored to emerging needs and applications.
- **International Association for Trusted Blockchain Applications (INATBA, 2024)**: INATBA's latest contributions in 2024 represent a significant expansion in the scope of DLT standards, incorporating recent technological advancements and addressing areas that require ongoing development, within both de jure and de facto standardisation activities.

3 BLOCKCHAIN STANDARDISATION NEEDS & RECOMMENDATIONS: EBSI

EBSI is a flagship initiative co-initiated by the European Commission and the EBP — a collaboration between all EU Member States, the European Commission, and countries like Norway and Liechtenstein — funded under the Digital Europe program.

The initiative aims to leverage blockchain technology to enhance cross-border services for public administrations, businesses, and citizens within the EU. EBSI's objectives align with the broader EU goals of promoting digital sovereignty, interoperability, and technological excellence.

EBSI was initiated in 2018, and its technical launch occurred in 2020 with the first prototypes and a web wallet solution based on the Hyperledger Besu and Fabric protocols. By autumn 2021, EBSI had advanced to version 2 (EBSI v2), incorporating enhancements and improvements based on initial feedback and further development efforts.

In the first half of 2024, under the Belgian Presidency, blockchain technology became a focus area, leading to the establishment of the European Digital Infrastructure Consortium (EDIC) for EBSI, officially launched in May 2024 to expand EBSI's scope and advance from the pilot stage on to full production.

3.1 EBSI: Role & Objectives

EBSI plays a crucial role in establishing a pan-European blockchain infrastructure that facilitates trusted and secure digital interactions across borders. By providing a permissioned blockchain network, EBSI ensures that only verified and authorised entities can participate, enhancing the security and trustworthiness of the data shared within the network. The infrastructure is designed to serve both the public and private sectors, offering a versatile platform for various applications to flourish.

3.1.1 Key Roles of EBSI

Facilitating Cross-Border Services

EBSI aims to streamline and enhance cross-border services for EU public administrations, businesses, and citizens by providing a trusted platform for verifying information and conducting secure transactions.

Enhancing Interoperability

One of EBSI's primary roles is to improve system interoperability across the EU. By utilising blockchain technology, EBSI enables the seamless integration of existing solutions and the development of new, interoperable services.

Supporting Digital Sovereignty

EBSI promotes the EU's digital sovereignty by ensuring that the infrastructure and data remain under European governance. This initiative supports the EU's strategic autonomy in the digital space.

Driving Technological Innovation

By fostering a collaborative environment for innovation, EBSI encourages the development of new blockchain-based solutions that can address various sector-specific challenges. This role is particularly evident through initiatives like the Early Adopters Programme, where over 154 companies are testing and developing services using EBSI's framework.

3.1.2 Objectives of EBSI

EBSI's objectives are aligned with the broader goals of the EU's Digital Decade Policy Programme 2030, which focuses on enhancing cooperation, technological excellence, and digital transformation across the continent. This alignment ensures that EBSI contributes to the EU's vision of a digitally empowered Europe by 2030, promoting a cohesive and innovative digital ecosystem. The Digital Decade Policy Programme 2030 sets ambitious targets for the digitalisation of public services, digital infrastructure, skills, and businesses, emphasising the importance of secure and efficient cross-border digital services, data sovereignty, and the adoption of cutting-edge technologies. EBSI supports these goals by providing a secure, interoperable blockchain infrastructure that facilitates trusted data exchanges and supports a digital identity framework.

Building a Trusted Infrastructure

The primary objective of EBSI is to create a robust and secure blockchain infrastructure that can be used for various applications, including public services, digital identities, and verifiable credentials. This infrastructure aims to provide a trusted environment for data sharing and verification.

Promoting Interoperability

EBSI seeks to connect existing digital solutions and enable the development of new interoperable services. By standardising data formats and utilising blockchain's inherent properties, EBSI reduces the need for complex system integrations, thereby simplifying cross-border interactions.

Supporting Public and Private Sector Use Cases

EBSI aims to serve both public and private sectors by providing a versatile infrastructure that can support a wide range of applications. This includes use cases in areas such as education, where verifiable credentials are used for diplomas, and supply chain management, where blockchain can enhance traceability and transparency.

Enhancing Digital Sovereignty

EBSI is designed to strengthen the EU's digital sovereignty by ensuring that critical digital infrastructure and data remain under European control. This objective is crucial for maintaining the EU's strategic autonomy in the digital space and fostering international partnerships based on mutual trust and cooperation.

Driving Innovation and Adoption

Through initiatives like the Early Adopters Programme and the Regulatory Sandbox, EBSI encourages innovation and the development of new blockchain solutions. These initiatives provide a testing ground for new technologies and help accelerate the adoption of blockchain across various sectors.

Ensuring Compliance with European Regulations

EBSI is committed to ensuring that all applications and services built on its infrastructure comply with European regulations and standards. This includes adhering to principles of data protection, privacy, and security, which are critical for gaining the trust of users and stakeholders.

3.1.3 Future Prospects: Full Production

Looking ahead, the evolution of EBSI is set to be driven by the establishment of EDIC, which took place in May 2024. This new framework will provide a legal and operational structure to support multi-country projects, ensuring more substantial funding and a **clear political mandate**. The integration of advanced technologies such as AI and quantum computing into EBSI's infrastructure will further enhance its capabilities and broaden its application scope.

Countries that are currently part of the Europeum EDIC: Belgium, Croatia, Cyprus, Greece, Italy, Luxembourg, Portugal (current Chair of Europeum EDIC), Romania, Slovenia, Poland (current Vice-Chair of Europeum EDIC).

EBSI's future as part of the EDIC initiative aims to strengthen Europe's digital backbone, making it a cornerstone for the digitalisation of public and private services. By promoting transparent and secure industrial processes, EBSI will contribute to the EU's strategic goals of digital sovereignty and technological leadership.

As Europeum EDIC is setting up their governance and operations throughout Q3 and Q4 of 2024, BlockStand will continue to assist and monitor the developments with the prospect of two related workshops to be organised in Q4 of 2024 and Q1 of 2025.

3.2 EBSI's Contribution to the European Blockchain Standardisation Landscape

EBSI plays a pivotal role in shaping the European blockchain standardisation landscape through its various initiatives and use cases. EBSI's current contributions are primarily focused on three main areas: verification of documents, verification of products and traceability, and verification of legal entities. These contributions are evident through several key initiatives and use cases.

3.2.1 Verification of Documents

EBSI has developed several use cases focused on the verification of documents, particularly in the education sector. This includes the creation of a secure and verifiable system for issuing and verifying educational credentials such as diplomas, transcripts of records, and micro-credentials. These initiatives ensure that educational qualifications can be trusted and recognised across borders within the EU, facilitating student mobility and lifelong learning. The standardisation efforts in this domain include defining formats and protocols for digital credentials, ensuring their interoperability across different educational institutions and countries.

In addition to educational credentials, EBSI supports the issuance and verification of other important documents, such as the European Qualification Passport for Refugees. This initiative allows for the recognition and verification of refugees' qualifications across the EU, ensuring that their skills and experiences are acknowledged and valued.

3.2.2 Verification of Products and Traceability

In the area of product verification and traceability, EBSI contributes significantly by enhancing the traceability of goods and services. This is particularly crucial for sectors like manufacturing and agrifood, where tracking the origin and journey of products is essential for quality assurance and regulatory compliance. EBSI's blockchain infrastructure supports the secure tracking of products from origin to end consumer, ensuring that all stakeholders can trust the information recorded on the blockchain. The standardisation efforts here involve creating common protocols for data recording and sharing, ensuring that different systems can interoperate seamlessly, and that traceability information is accurate and reliable.

3.2.3 Verification of Legal Entities

EBSI also focuses on the verification of legal entities, providing a secure and standardised method for verifying the identity and credentials of organisations and individuals. This is particularly relevant for regulatory compliance and financial transactions, where verifying the legitimacy of entities is crucial. EBSI's solutions include blockchain-based systems for the issuance and verification of business credentials and professional licenses, which enhance trust and reduce the risk of fraud. The standardisation contributions in this area involve defining the

data structures and verification processes for legal entities, ensuring that they are consistent, secure, and compliant with EU regulations.

3.2.4 Other Key Contributions

Public Administration and Interoperability

EBSI supports the interoperability of public administration services by providing a blockchain-based infrastructure that enables secure and efficient data exchange between different governmental entities. This is crucial for the seamless provision of cross-border public services. The standardisation contributions here involve setting protocols for data exchange, ensuring compliance with data protection regulations, and creating interoperable digital wallets for citizens and public administration entities.

Vocational Education and Training

In the field of vocational education and training (VET), EBSI has implemented solutions that allow for the secure issuance and verification of vocational credentials. This enhances the credibility of VET certifications and supports the recognition of skills and qualifications across Europe. The standardisation in this area involves creating uniform standards for the issuance of VET credentials, ensuring they are recognised and trusted across different EU Member States.

Environmental and Sustainability Credentials

EBSI also contributes to the standardisation landscape by supporting environmental and sustainability initiatives. For example, it facilitates the issuance and verification of credentials related to environmental sustainability and climate change mitigation. These use cases ensure that sustainability claims are verifiable and trusted, promoting transparency and accountability. Standardisation efforts include defining the data structures and verification protocols for sustainability credentials, ensuring that they are interoperable and can be easily validated across different platforms and systems.

Healthcare and Professional Licenses

In the healthcare sector, EBSI supports the issuance and verification of professional licenses, ensuring that healthcare professionals can have their credentials recognised across borders. This enhances mobility and ensures that healthcare services can be delivered efficiently. Standardisation efforts focus on defining the formats and verification processes for professional licenses, ensuring they meet the regulatory requirements of different EU member states.

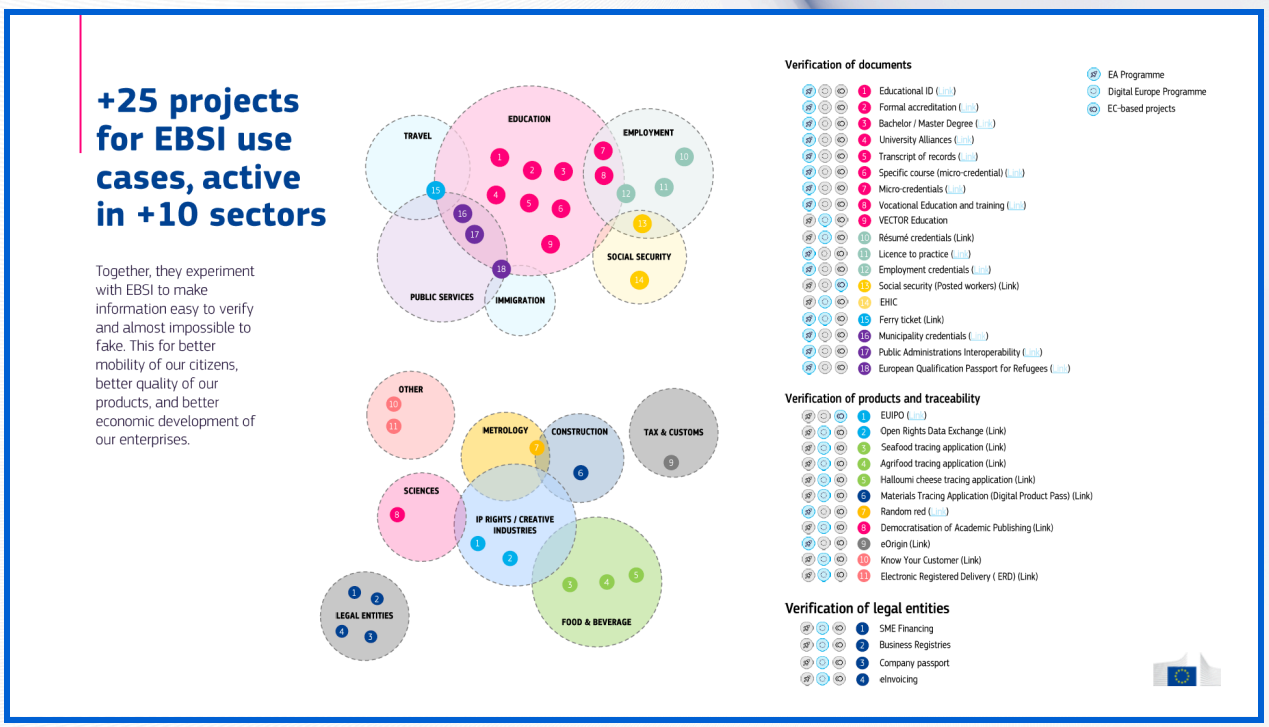

Figure 3: 25+ projects for EBSI use cases, active in 10+ sectors. Source: EBSI team - DG Digit - European Commission.

3.2.5 Overall Impact on Standardisation

EBSI's initiatives significantly contribute to the development of blockchain standards that promote interoperability, security, and trust across these key areas. By implementing robust verification systems for documents, products, and legal entities, EBSI sets benchmarks for the secure and efficient use of blockchain technology. These standardisation efforts ensure that blockchain applications are scalable, interoperable, and compliant with EU regulations, fostering a cohesive and trustworthy digital ecosystem across Europe.

Through its contributions, EBSI not only enhances the functionality and reliability of blockchain applications but also provides a foundation for future innovations and developments in the blockchain space. Its role in the European blockchain standardisation landscape is crucial for building a resilient and forward-thinking digital infrastructure that meets the needs of all stakeholders. EBSI's influence extends beyond Europe, setting standards and providing a **blueprint for other wide public service blockchain infrastructures globally**.

3.3 Identified Standardisation Gaps and Needs for the Implementation of Blockchain Solutions

3.3.1 Primary Areas Requiring Standardisation

The successful implementation of blockchain solutions within EBSI hinges on addressing several critical standardisation gaps and needs, as identified by the European Commission DG DIGIT in the Key Action Points to be covered by SEEBLOCKS & BLOCKSTAND projects, based on the policy objectives for DLT – Rolling plan for ICT Standardisation. These gaps, if unaddressed, can hinder interoperability, security, and regulatory compliance. The primary areas requiring standardisation include:

1. Trust Anchor Management Infrastructure

- Technical Specifications and Protocols: It is essential to define and standardise the technical specifications and protocols required for EBSI to function as a trust anchor management infrastructure. This involves creating seamless onboarding processes for trust anchors and ensuring compatibility with various data formats such as JSON-LD, XML, JWT, and CBOR. These formats need to be interoperable and adaptable to different types of data sources to facilitate efficient data sharing.
- Proof Verification Mechanisms: Establishing standardised methods for verifying the authenticity and integrity of proofs associated with trust anchors is crucial. Mechanisms like digital signatures, hash-based verification, timestamp verification, PKI verification, blockchain attestations, zero-knowledge proofs, and multi-signature verification must be standardised to ensure seamless validation and adherence to predefined criteria.

2. DLT-Based Proof EBSI Profile

- Creation and Validation of Verifiable Credentials (VCs): Standardisation is required for creating and validating DLT-based VCs for eSignatures and eSeals. This includes developing robust processes for identity verification, cryptographic key generation, and binding essential attributes to the credential. The validation process should leverage the transparency and immutability of DLT to enable efficient verification of credential authenticity.
- Standardisation of Interfaces and Services: To ensure seamless integration across the EBSI ecosystem, it is vital to standardise interfaces for eSeal/eSignature validation and the creation services. This includes defining uniform protocols and methods for verifying the validity of digital signatures and establishing guidelines for generating secure digital signatures anchored in a tamper-resistant environment.
- DLT-Based Trusted List and JADES Signatures: Standardising the creation of a DLT-based trusted list and JADES (Joint Algorithm for Digital Signatures) signatures is essential to support DLT-proofs. These standards will ensure the integrity and authenticity of transactions within the EBSI ecosystem and provide a reliable repository of verified entities and their associated credentials.

3. Qualification of Ledgers as Trust Services

- Development of Standards and Technical Specifications: There is a need to develop rigorous standards and technical specifications to qualify DLT-based ledgers as trust services. This includes ensuring data integrity, immutability, cryptographic security, and compliance with legal and regulatory requirements. These standards must align with the EBSI initiative and be tested within the EBSI sandbox to ensure their effectiveness in real-world scenarios.
- Alignment and Testing: The qualification process must align closely with the EBSI initiative. The EBSI sandbox provides an ideal environment for testing the developed standards and technical specifications within a controlled and secure ecosystem, allowing for iterative improvements based on practical feedback.

4. Smart Contract Business Processes

- Standardisation of Business Processes and Security: It is crucial to standardise smart contract business processes, focusing on syntax, semantics, contract lifecycle, data privacy, security protocols, and compliance with legal frameworks. Robust security considerations and best practices must be integrated into the standards to mitigate potential vulnerabilities and ensure the reliability of smart contract operations.
- Benefits of Standardisation: Standardised smart contracts will enable seamless interactions across different systems and platforms, promote cross-border collaboration and interoperability, enhance transparency, ensure legal compliance, and simplify development, integration, and maintenance efforts.

These identified standardisation gaps highlight the necessity of creating a comprehensive framework that addresses the diverse needs and challenges of implementing blockchain solutions within the EBSI. Addressing these gaps will foster a secure, interoperable, and compliant blockchain infrastructure.

3.3.2 EBSI Stakeholders Perspective

The analysis of the questionnaire responses reveals several key insights into the standardisation gaps and needs from the perspective of EBSI stakeholders. A significant portion of respondents, 80.85%, are aware of the EBSI, while 52.63% of organisations are currently involved or plan to be involved in EBSI activities.

The roles that these stakeholders occupy within EBSI are diverse, with many serving as trusted verifiers, issuers of verifiable credentials, digital wallet providers, node operators, and technological developers.

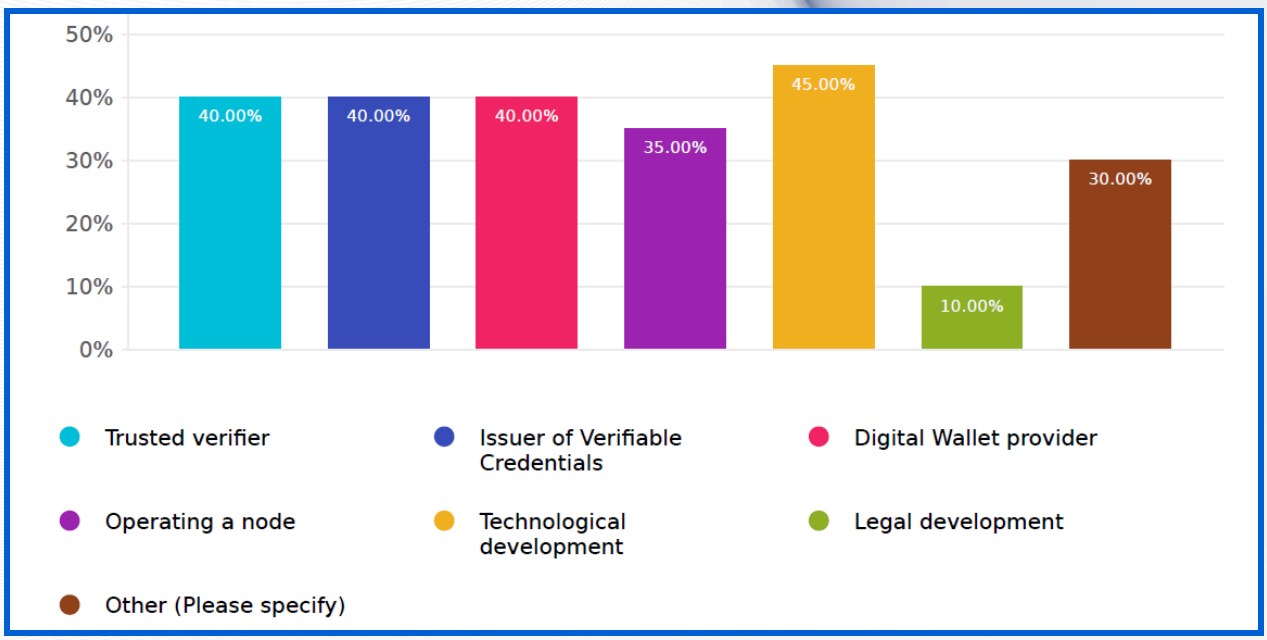

Figure 4: EBSI stakeholders.

EBSI stakeholders are engaged in various use cases, including manufacturing traceability, agrifood tracking, identity verification, diploma issuance, and micro-credentials. However, some respondents noted challenges in accessing specific use cases.

The stakeholders have also identified several future use cases they would like EBSI to prioritise. These include enhancing the traceability of goods across borders, improving security measures and aligning them with standardisation efforts, and providing trusted data sharing and document tracing services.

Additionally, they have highlighted the need for facilitating verified attestations in education, employment, and lifelong learning, services linked to environmental sustainability and climate change mitigation, ensuring interoperability between different blockchain systems, promoting decentralisation, and providing cloud wallet platforms accessible via APIs for verifiable credentials.

3.4 Policy & Standardisation Recommendations

Following the recommendations from the European Commission DG DIGIT's Key Action Points to be covered by SEEBLOCKS & BLOCKSTAND projects, discussions held by the Technical Coordination Board and Executive Management Board of BlockStand, the following policy and standardisation recommendations are proposed to address the identified gaps and ensure the successful implementation of blockchain solutions within EBSI:

1. Collaborative Efforts with EBSI-NE

- Synergy and Alignment: Work closely with EBSI National Nodes and Entities (EBSI-NE) to ensure alignment and consistency across different regions and projects. Collaboration

between EBSI and EBSI-NE will harness synergies, avoid duplication of work, and prevent contradictory approaches. This unified effort will enhance the regional relevance of EBSI solutions and ensure that the benefits of the initiative are maximised.

- Regional Insights and Relevance: EBSI-NE brings valuable regional insights and expertise tailored to the specific needs and challenges of individual Member States. Collaborating with EBSI-NE allows EBSI to tap into these nuances, ensuring that the initiative's solutions are effective and contextually relevant.

2. Engage Experts in the Field

- Domain Expertise: Actively involve domain experts and stakeholders in the standardisation process. Engaging these experts ensures that the resulting standards are well-informed, accurate, and reflective of the latest advancements and challenges. Their specialised knowledge and insights will enrich the standardisation process, making the standards applicable to real-world contexts.
- Holistic Perspective: Involving stakeholders, including businesses, government entities, academia, and consumers, brings a holistic perspective that considers the varied needs and expectations of different segments of the population. This engagement fosters a sense of ownership and commitment among stakeholders, promoting trust and acceptance of the standards.
- Call for Experts Initiative: The BlockStand Consortium's "Call for Experts" initiative is a valuable step in engaging seasoned professionals in the standardisation process. This initiative invites experts to contribute their insights and expertise, playing a vital role in shaping the future of blockchain technology and its integration within frameworks like EBSI.

3. Alignment with Regulations

- Regulatory Compliance: Ensure that all standardisation efforts align with relevant European regulations, including eIDAS and the Data Act. This alignment guarantees legal compliance, user privacy, and interoperability within the European digital ecosystem. Adhering to these regulations will bolster the credibility and acceptance of the standards.
- Framework Adaptation: Align the standards with evolving regulatory frameworks to ensure they remain relevant and compliant with new legal requirements. This proactive approach will ensure the sustainability and adaptability of the standards over time.

4. Testing and Evaluation:

- EBSI Sandbox Utilisation: Utilise the EBSI sandbox for rigorous testing and evaluation of proposed standards in practical scenarios. The sandbox environment provides a controlled setting to experiment with and refine the standards, allowing for iterative improvements based on real-world feedback.
- Iterative Improvement: Continuous testing and evaluation will ensure the robustness and applicability of the standards. This approach will enable the identification and

resolution of potential issues, leading to more reliable and effective standardisation outcomes.

These recommendations aim to create a harmonised and secure blockchain infrastructure that fosters innovation, trust, and efficiency across Europe. By addressing standardisation needs, engaging experts, aligning with regulatory frameworks, and rigorously testing the standards, the EBSI platform can effectively support the seamless integration and widespread adoption of blockchain solutions.

4 BLOCKCHAIN STANDARDISATION NEEDS & RECOMMENDATIONS: R&I COMMUNITY

4.1 R&I Community: Role & Best Practices in the EU Blockchain Standardisation Landscape

The R&I community plays a crucial role in shaping the EU's blockchain standardisation landscape. By engaging in cutting-edge research, fostering innovation, and collaborating with industry stakeholders, the R&I community helps to establish robust and effective standards that promote the adoption and integration of blockchain technologies across various sectors.

To support these efforts, the European Commission has been active in exploring research and funding needs related to blockchain and DLT. Mainly through the Horizon 2020 and Horizon Europe Programmes, the European Commission has funded several EU projects in which blockchain and DLT contribute to the emergence of new paradigms of trust as well as societal, technical and infrastructural solutions. Currently, already EUR 347 million of EU funding has been planned and used to support blockchain-related research and innovation projects and pilots.

A comprehensive overview of past and ongoing EU-funded blockchain-related projects, together with their sector of focus and linked activities, is publicly accessible on the European Commission's website.

The Commission also manages other important initiatives such as the European Blockchain Observatory and Forum (EUBOF), which aimed to accelerate blockchain innovation and the development of the blockchain ecosystem within the EU, thus promoting Europe's position as a global leader in this transformative new technology. One major accomplishment of the Observatory was the creation of a network of experts across the world, instrumental in mapping projects, initiatives, educational programs, and training, linking stakeholders from the blockchain ecosystem globally. A collection of European and international blockchain initiatives can be found on the EUBOF's Interactive Map.

In light of its strategic importance and as part of T2.3, the BlockStand consortium carried out a comprehensive analysis of the standardisation needs for EU and nationally funded projects, as well as the broader R&I community, including research organisations and universities. This analysis involved surveying stakeholders in the blockchain R&I sector through a detailed questionnaire and supplementary interviews.

The questionnaire explored topics crucial to the R&I stakeholders, such as involvement in EBSI use cases; blockchain relevance, adoption, involvement, and experience; skills and competencies required for implementing various solutions; and an analysis of customer/stakeholder needs and priorities. The results provide a comprehensive overview of gaps and mismatches, serving as a valuable resource for developing policy and standardisation recommendations that reflect the needs of the R&I community, as well as SMEs and EBSI stakeholders.

To complement the inputs gathered through the survey, the BlockStand consortium conducted additional, in-depth interviews with selected representatives of the R&I community. In

particular, relevant insights on the standardisation gaps and recommendations were collected from experts affiliated to:

- TRACE4EU. The general objective of the project is to create an "umbrella architecture" based on existing EBSI services. The architecture builds the basis for the realisation of traceability application scenarios. Furthermore, TRACE4EU focuses on engaging with pan-European stakeholders and on promoting recommendations for further development of the EBSI ecosystem. As a result, TRACE4EU can significantly influence traditional industries and contribute to their transition to more efficient, productive, competitive, and resilient ones. As the project places a strong emphasis on research and innovation activities, driving forward technological advancements and novel solutions, its contribution has been considered fundamental.
- Nordic Blockchain Association. The Nordic Blockchain Association (NBA) is a nonprofit organisation facilitating the largest professional web3 network in the Nordics with a mission to drive the responsible and sustainable growth of blockchain technology. Through its main activities related to research and innovation, such as education, advocacy, and collaboration, NBA aims to advance the development of supportive legislation, infrastructure, and a vibrant ecosystem that empowers and harnesses the full potential of blockchain in the Nordics.
- Fraunhofer Blockchain Lab. The Fraunhofer Institute for Applied Information Technology FIT has been developing IT solutions tailored to people and seamlessly integrated into business processes for 40 years. Fraunhofer's Blockchain Lab is a multi-disciplinary unit that designs, develops and evaluates blockchain applications. Their main area of work is to transfer the latest R&D results in this young field into practical, integrative applications, putting special emphasis on short development cycles.
- Blockchain & Climate Institute. The Blockchain & Climate Institute (BCI) is a progressive think tank providing leading expertise in the deployment of emerging technologies for climate and sustainability actions. As an international network of scientific and technological experts, BCI is at the forefront of innovative efforts, enabling technology transfers, to create a sustainable and clean global future. A key focus of BCI is on R&I activities, driving the development of cutting-edge solutions to address climate challenges.
- Blockchain for Europe. Blockchain for Europe is a Brussels-based membership organisation for companies driving innovation, integrity and empowerment through blockchain. The organisation collaborates with policymakers, academics and its member companies to develop a European regulatory framework that supports and promotes blockchain-based innovation.
- University of Tartu. The University of Tartu is the leading university in the Baltics in information technology with ground-breaking and internationally recognised research in IT. In addition to the past involvement in EU-funded projects, the university remains committed to strengthen ICT professionals' key competences and update their digital skills related to advancements and applications of blockchain technology.

While the interviews employed most of the questions used in the survey to ensure consistency, this format allowed the BlockStand team to gather additional qualitative data directly from the experts.

4.2 Identified Standardisation Gaps & Needs

The above-mentioned survey engaged 13 organisations[1] from the R&I community. Of these participants, 53.85% were Research and Innovation Institutions or Universities, while 46.15% were Educational Institutions. Geographically, 53.85% operated at a national level, 30.77% had an international presence, and 7.69% worked regionally.

The dominant sector among respondents was Digital, representing 53.85%, with notable participation also from other sectors such as Education, Electrical Engineering, and Business & Finance, each at 46.15%.

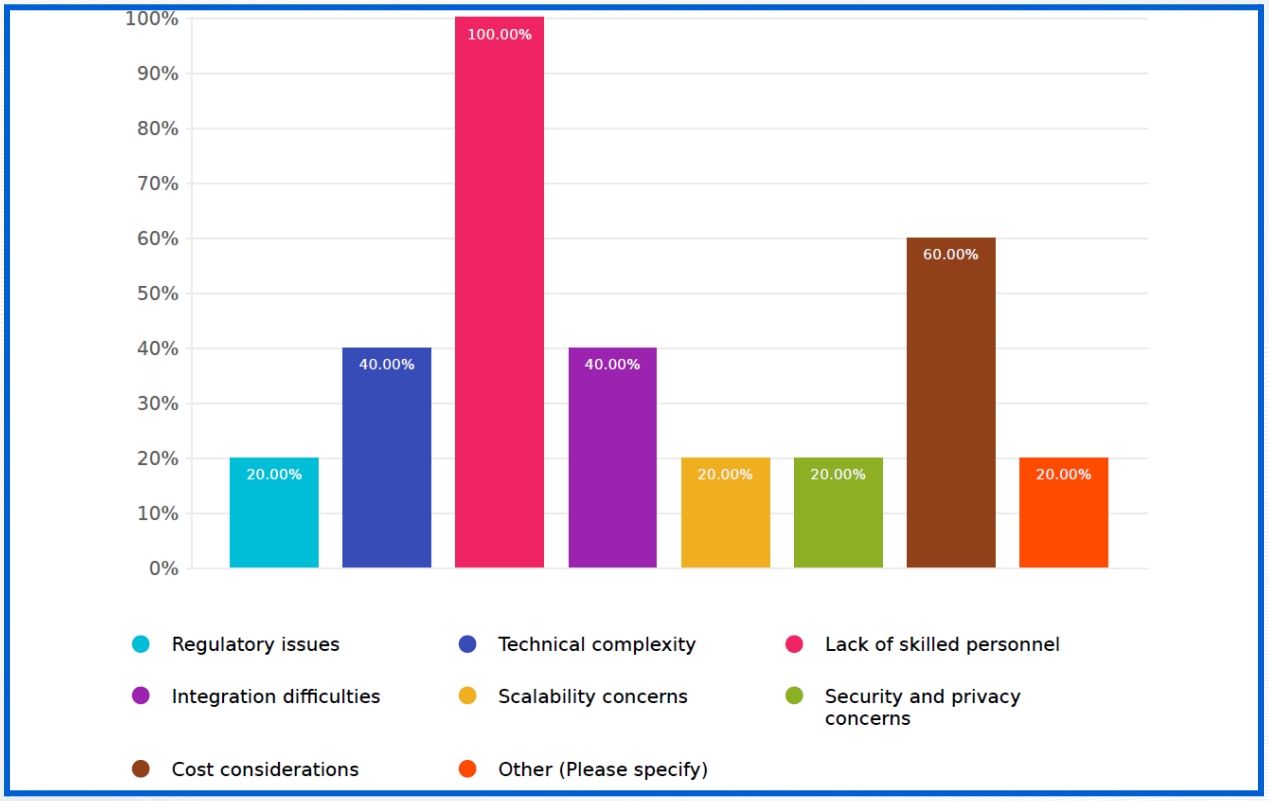

Figure 5: R&I: What challenges or obstacles have you encountered in adopting or implementing blockchain technology?

[1] University of Maribor, Institute of informatics; Politehnica University of Timisoara (UPT); RISE AB; Riga Technical University; Blockchain Ukraine; University of Tartu; DIEK Aigaleo; University of Copenhagen; University of Ljubljana; Baden-Wuerttemberg Cooperative State University Karlsruhe; Norwegian University of Science and Technology; Hochschule Mittweida.

The survey results show that blockchain is important to most of the respondents' organisations. About 43% find it relevant and another 43% find it very relevant, while only one respondent (14%) is neutral.

A notable finding from the survey was that 76.92% of respondents acknowledged the significance of EBSI. Additionally, 70% of these organisations were either currently engaged with or planning to engage with EBSI. Their roles primarily included serving as Issuers of Verifiable Credentials and Node Operators, with common applications centred around Diplomas and Micro-Credentials.

The survey highlighted a balanced distribution between blockchain technology users and non-users/providers. Most respondents had over two years of experience with blockchain technology, with key adoption goals being enhanced security and transparency (60%) and asset tokenisation (40%). However, challenges such as a shortage of skilled personnel (reported by 100% of respondents) and cost considerations (60%) were prevalent.

Blockchain technology was considered relevant or very relevant by 85.72% of participants with key applications including personal identity security with 71% of respondents working on it, money transfers, like cryptocurrencies and payments, used by 57% and Smart contracts and NFTs each explored by 43%.

Most respondents rated their blockchain expertise as intermediate or novice, with decentralisation (85.71%) and enhanced security (57.14%) being the primary benefits cited. Awareness and involvement with regulations like eIDAS2 and the Data Act varied, with most participants having basic or intermediate engagement levels.

The main benefits of blockchain, according to the respondents, include **decentralisation** (86%), **security** (57%), **privacy** (57%), and **sustainability** (57%). One respondent also highlighted blockchain's potential to create new value in digital ecosystems and the importance of standardising the technology.

The importance of standardisation was recognised by 50% of respondents as crucial and by 33.33% as important. Familiarity with relevant standards was high at 70%, and some participants were engaged in national and international standardisation activities, notably ISO/TC 307.

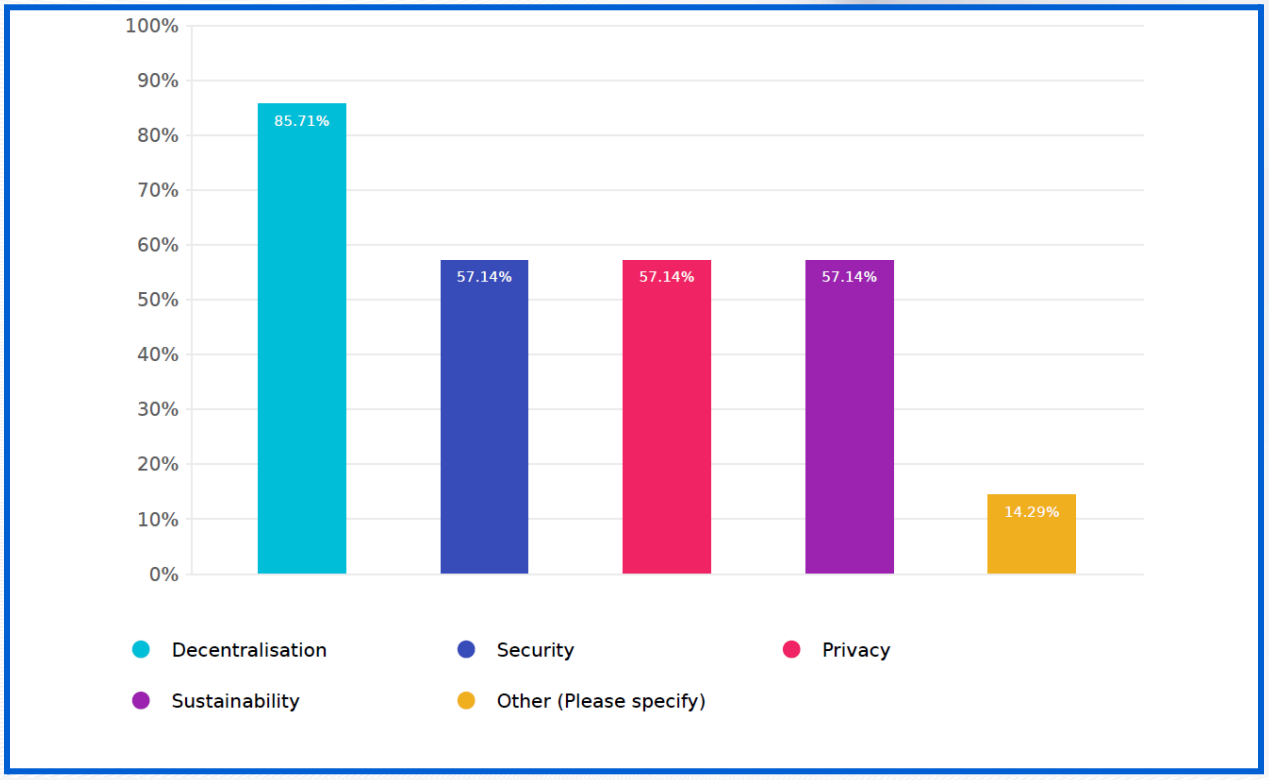

Figure 6: R&I: What are the main benefits enabled by blockchain or DLT solutions to your activity?

Feedback on current standards supporting blockchain technologies was varied, with opinions ranging from poorly (20% of respondents) to very well supported (20% of respondents). Another 20% are neutral, while 20% think standards support blockchain moderately well.

Two comments provide further insight on this matter: one respondent highlighted that existing standards are too detailed and complex, focusing too much on data formats. This creates additional challenges to innovation, quick adaptation, and involvement from smaller companies.

Another respondent believes that standardisation efforts are lagging industry developments. For instance, while initiatives like eIDAS 2 are seen as a progress, they do not fully leverage the advancements made in self-sovereign identity (SSI) research and development.

Respondents to the question on specific issues encountered while using or providing blockchain technology identified several areas that could be addressed through standardisation: a shortage of experienced personnel (30% of respondents), fragmentation in the blockchain landscape (20%), complexity in the technical specifications of blockchain (10%), and interoperability challenges.

The R&I community has also been asked to identify challenges or issues that could be better addressed through standardisation. In this case, respondents mentioned **interoperability** issues (80%), indicating a clear need for new standards that could benefit different blockchain systems. **Technical implementation** (60%) was another area where standardisation could help, as well as **innovation** and **new use cases** (40%). Lastly, specific definitions or

requirements (30%) are considered fundamental to making blockchain technology more comprehensible and manageable.

Moreover, respondents shared their thoughts on the challenges of using blockchain standards more widely. One major issue is **security**, additionally, as already mentioned, there is a need for more **information** and **training** on blockchain standards to better understand and use them. Another challenge is that regulations need to cover more types of blockchain systems. Finally, it was noted that R&D in the blockchain field don't always go at the same pace as standards.

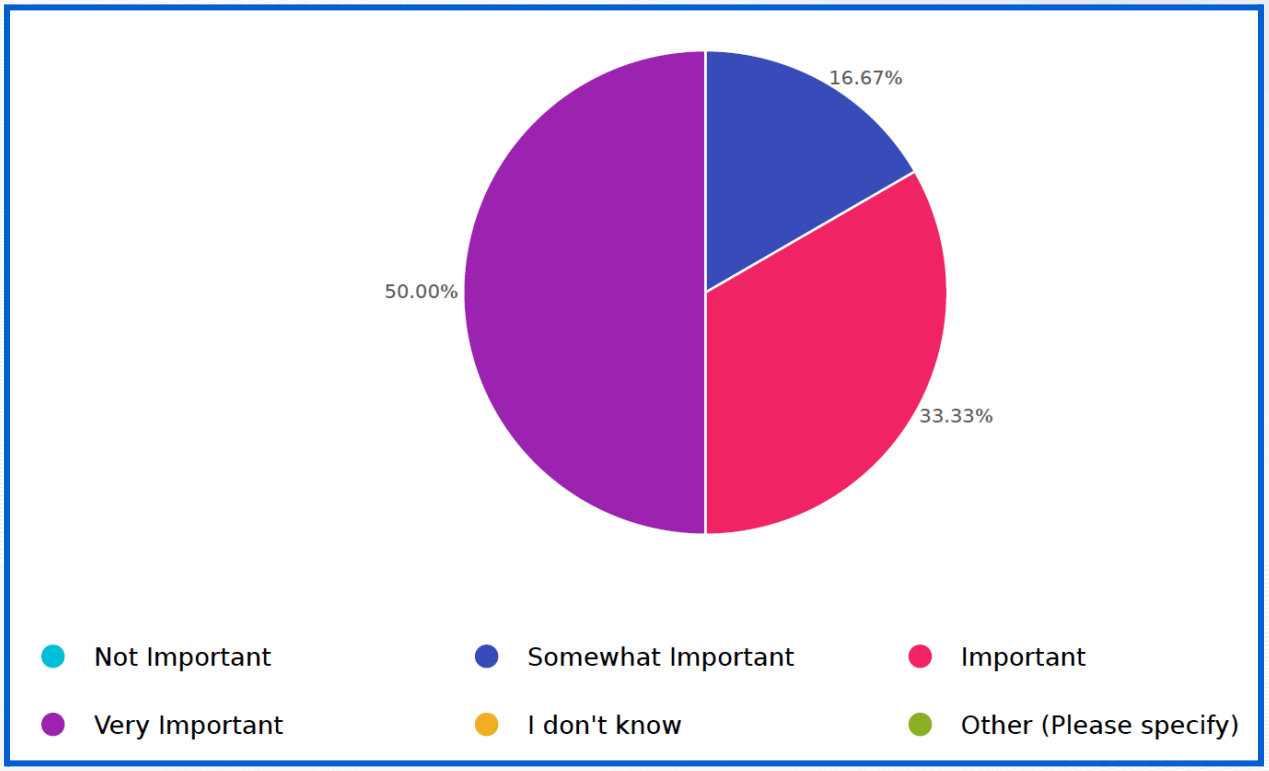

Figure 7: R&I: How important do you believe blockchain standardisation is for the growth and adoption of blockchain technology for the EU industry?

When it comes to blockchain standardisation, most respondents believe that the focus should be on creating standards that work **across different industries** (67%). This approach is seen as more beneficial because it provides a common framework that can be applied widely, rather than creating separate standards for each industry (22%). Moreover, one respondent mentioned that instead of focusing only on specific data formats or protocols, standardisation should emphasise how different components of a blockchain system should interact, also setting clear rules on different components. Another point made is that while industry-specific standards are important, they can lead to divisions and may not keep up with the rapid changes and innovations in blockchain technology. Given how quickly the field is evolving, having broad, cross-industry standards could have a greater positive impact.

In relation to the top priorities for blockchain standardisation, respondents highlighted a few key areas. The most important priority, mentioned by everyone (100%), is developing the **European Digital Identity/EU Digital Identity Wallet**, thus suggesting a strong focus on

fostering the creation of a unified digital identity system across the EU. Following that, 67% of respondents think that **Verifiable Credentials (VCs) for electronic signatures and seals** should be a major focus, showing a need for reliable and trustworthy methods addressing these issues. Trust Anchors Management and conformity with the eIDAS regulation were also mentioned by 22% of respondents who see these areas as important but not as critical as the first two.

A few additional comments on one hand pointed out that interest in blockchain technology might be decreasing, on the other emphasised the need for standardisation bodies to work more closely with existing blockchain ecosystems and users. This includes collaborating with open-source projects, W3C efforts, and various blockchain platforms to improve communication and integration across different technologies and ensure that technological solutions are globally applicable.

As previously mentioned, to gather additional insights, inputs, and comments, interviews with the organisations mentioned in the paragraph 4.1were conducted. During these interviews, most of the questions from the survey were asked, but interviewees were also given the opportunity to elaborate on the points they considered most significant.

The feedback gathered corroborated and expanded upon the questionnaire's findings. Among the interviewees, 50% represented international organisations, 33.3% had a European focus, and 16.7% were oriented nationally. This distribution was consistent with the survey results, which also showed a strong presence of Educational Institutions (33.3%) and R&I Institutions/Universities (33.3%), alongside sectoral/industrial associations (16.7%) and EU project consortia (16.7%).

Awareness of the EBSI was evenly distributed among respondents, reflecting a balanced level of engagement with this initiative.

When it comes to the main benefits provided by blockchain and distributed ledger technologies (DLT), the majority of respondents highlighted **decentralisation** and **security**, considered the top advantages (with 60% and 80% of interviewees respectively emphasising their importance); **privacy** is also considered as fundamental as it was mentioned by 40% of respondents. **Sustainability** was noted by 20% of participants. A comprehensive view that includes all four benefits—Decentralisation, Security, Privacy, and Sustainability—was recognized by 30% of the interviewees.

While there was a familiarity with the activities performed by different SDOs such as ISO, ETSI, CEN-CENELEC and IEEE, only 50% were actively involved in technical committees or working groups, revealing a gap between awareness and active participation. To address this gap, interviewees advocated for **targeted initiatives** such as seminars and short courses to enhance expertise in blockchain standardisation.

All interviewees, in fact, acknowledged the critical importance of blockchain standardisation for the EU industry in general, with 67% rating it as very important for advancing technology adoption.

Furthermore, about 83% of respondents believe that blockchain standards and standardisation have a significant impact on their organisations. Specifically, 50% think these standards have a high impact because they help in creating organised processes, ensuring clarity, and aligning with established norms, which guides blockchain activities effectively. Around 33% see the

impact as ranging from high to extremely high, particularly highlighting their importance for smart contracts and NFTs.

Challenges such as the **complexity of technical specifications**, **fragmentation**, and a **lack of skilled personnel** were universally acknowledged and also in this group there is a clear call for more **horizontal, cross-industry standards** and **targeted training programs** to enhance expertise in blockchain standardisation.

Regarding the specific challenges or issues that could be improved through standardisation, 50% of respondents highlight **technical implementation** and **interoperability** as key areas. This indicates a need for standards to help deploy blockchain technology effectively and ensure different blockchain systems can work together. Additionally, 33% of respondents mention that challenges related to i**dentity management, specific definitions/requirements, sustainability, and innovation** could also benefit from standardisation.

On the challenges encountered with blockchain technology that standardisation could address, 50% of respondents point to the complexity of technical specifications and the lack of experienced personnel. Furthermore, 33% of respondents cite accessibility, fragmentation, security issues, and representation as significant challenges that could be improved through standardisation.

Additionally, effective knowledge transfer and increased awareness through events and focus groups were emphasised as crucial for addressing these challenges and fostering greater participation in the development of blockchain standards.

When it comes to the top three priorities for blockchain standardisation, all respondents stress the importance of **Verifiable Credentials for eSignature/eSeal**. 83% mention the **European Digital Identity/EU Digital Identity Wallet** highlighting the need for a stronger focus on creating a standardised, interoperable digital identity system in Europe to ensure secure access and verification. About 67% prioritise **smart contracts**, noting their relevance in areas like the Data Act, while 33% mention custodial standards.

Additional insights from the interviewees reveal that blockchain standardisation has gained significant attention recently, but there is still a disconnect between EU standardisation initiatives and industry practices. To address this, it's important to integrate EU and industry efforts, prioritise standards that considered "industry-friendly", and streamline the standard-making process to reduce implementation time. Additionally, the current fragmentation in the standardisation landscape, with multiple organisations working on similar issues, highlights a need for better collaboration as coordinated efforts to address this fragmentation could lead to more cohesive and effective standardisation.

Participants also pointed out that regulations requiring the use of blockchain, especially if made mandatory, could significantly drive its adoption and enhance its legal and technical acceptance.

Additionally, there is a call for increased collaboration between various projects, particularly EU initiatives. This includes the need for EU institutions to establish platforms that facilitate information exchange among different stakeholders and project leaders.

4.3 Policy & Standardisation Recommendations

From the analysis of the responses and the information collected, several key recommendations have emerged from the R&I sector. This section aims to enhance standardisation efforts and support the widespread adoption and integration of blockchain technology across diverse applications:

- As shown in the Figure 5, the lack of skilled personnel is considered as an obstacle for the advancement of blockchain technology and standardisation. It is therefore crucial to develop specialised **educational and training programs, including workshops, seminars and courses,** tailored to enhance practical skills and prepare stakeholders for active participation in standardisation efforts. Industry-academia collaboration should be fostered to create relevant and **up-to-date curricula** and **training modules** aligned with real-world blockchain challenges and industry needs. These enhanced training and education programs should target academia, industry professionals, and public bodies to bridge the current skills gap and build a robust workforce capable of driving blockchain innovation. Additionally, certification programs and continuous learning opportunities should ensure ongoing professional development in blockchain technologies.

- Develop **cross-industry** and **cross-sector blockchain standards** to enhance **interoperability** and **integration across diverse applications**. This strategy will ensure that standards respond to the diverse needs of different fields and enable smooth interactions between them. Achieving this requires the active involvement of a broad range of stakeholders in the standardisation process. Their participation will help create frameworks that are inclusive, relevant, and valuable across different use cases. This collaborative approach is considered fundamental for a cohesive ecosystem where blockchain technologies can be effectively integrated and utilised across a wide array of industries.

- As highlighted by all respondents to the questionnaire and by 83% of interviewees, a key blockchain standardisation priority is identified in the **European Digital Identity/EU Digital Identity Wallet**. The aim is to ensure secure, interoperable access and verification across the EU. Further efforts in this regard are therefore encouraged also considering the latest updates in the EU legislation.

  In this direction goes in fact the Regulation (EU) 2024/1183 establishing the European Digital Identity Framework (the "eIDAS 2 Regulation") which entered into force on **20 May 2024** and amends Regulation (EU) 910/2014 on electronic identification and trust services for electronic transactions in the internal market (the "eIDAS Regulation").

  Moreover, according to Article 5a, by 21 November 2024, the Commission shall, by means of Implementing Acts, **establish a list of reference standards** and, where necessary, **establish specifications** and **procedures for the implementation of the European Digital Identity Wallet**. These Acts will be informed by the requirements and specifications developed by Member State Experts who are working together to set up the EU Digital Identity Toolbox with the aim of ensuring uniform implementation of wallets across Europe.

As the eIDAS 2 Regulation mandates Member States to provide EU Digital Identity Wallets to citizens within 24 months of Implementing Acts adoption, outlining technical specifications and certification, enhancing experiences and efforts in this regard will be fundamental for the EU Countries.

Large-scale pilot projects are also in progress to test technical specifications and software prototypes for the EU Digital Identity Wallet across various sectors in multiple European countries.

The need for **clearer guidance and support regarding eIDAS 2** will become more and more crucial to foster the harmonisation of regulatory requirements across jurisdictions thus simplifying compliance and facilitating the adoption of blockchain solutions across borders.

- As all the interviewees and 67% of the respondents to the questionnaire agree on the importance of **Verified Credentials for electronic signatures and seals**, further efforts in this sense are encouraged. As already mentioned, e-signing and e-sealing define how natural persons and legal entities can digitally sign VCs and VPs.
  In our analysis, these elements are particularly important as they are components of EBSI's Trust Model as they guarantee the origin, authenticity and integrity of the signed information.
  Advancing the standardisation of these credentials is essential for establishing reliable and trustworthy methods for digital transactions, which are crucial for legal and official purposes within the EU. The current standards and recommendations landscape is mainly driven by the above-mentioned eIDAS 2 Regulation, World Wide Web Consortium (W3C), EBSI, OpenID Connect and will require further efforts, especially in the implementation phase.
  In this sense, enhancing the collaboration among stakeholders, elaborate new pilot testing, and systematic feedback loops could be useful to refine and enhance these standards.
- As outlined by many respondents, the development of standardised frameworks for **smart contracts** is crucial for facilitating their broader adoption and integration into various use cases. Particularly important are considered the applications such as those outlined in the Data Act which entered into force on 11 January 2024, and that will become applicable in September 2025. The questionnaire revealed that most respondents had an average or general understanding of the Data Act showing once more the need for more guidance and knowledge sharing with this regard.

- It is recommended to address **specific challenges** through standardisation, as most interviewees and respondents to the questionnaire emphasise the need for standardisation in both **technical implementation** and **interoperability**. This reflects the necessity for more robust frameworks supporting effective blockchain technology deployment and the development of standards enabling different blockchain systems to work together. Additionally, challenges such as **identity management**, **specific definitions/requirements, sustainability, and innovation** should also be prioritised.

- As mentioned, **strengthen support for blockchain regulations** and **standards** also providing comprehensive guidance and support for organisations dealing with blockchain-related regulations, including eIDAS2 and the Data Act, is also mentioned as

a crucial point by many surveyed people. Offer resources such as **workshops**, **advisory services**, and detailed **compliance toolkits** to help stakeholders effectively meet regulatory requirements. Additionally, advocate for the harmonisation of regulatory standards across different jurisdictions to streamline compliance processes and facilitate the implementation of blockchain solutions internationally.

- Increase **funding** through **targeted grants** and **financial incentives** to bolster research and development in blockchain technology and standardisation. This support should help organisations overcome financial barriers and invest in critical technological tools and infrastructure. Additionally, prioritise the advancement of **technical infrastructure** by providing resources for the development of state-of-the-art tools and platforms that enhance collaboration and technical innovation. Establish **collaborative platforms** to facilitate **information exchange** and **coordinate efforts** among different **blockchain projects** and **regulatory bodies** at the EU level, ensuring cohesive progress and alignment across the sector.
- **Encourage active participation in standardisation efforts** developing incentives and programs to drive engagement in TCs and WGs. This can include offering financial support for participation costs, providing public acknowledgment, and implementing additional forms of encouragement.
- Finally, bridging the gap between **EU standardisation efforts** and **industry practices** is essential. This includes focusing on **industry-friendly approaches** and **reducing implementation times** to ensure that standards are relevant and practical for real-world applications. Addressing the fragmentation within the standardisation landscape, where multiple organisations work on similar topics without adequate collaboration, will be crucial in achieving more effective and unified standards development.

5 BLOCKCHAIN STANDARDISATION NEEDS & RECOMMENDATIONS: SMEs

5.1 SMEs: Role & Best Practices in the EU Blockchain Standardisation Landscape

SMEs play a vital role in all aspects of the EU blockchain landscape. They can be providers of blockchain services, to customers and to other businesses, and as users of blockchain in their economic activity, acting at all levels of different value chains.

That is why an even deeper and widespread involvement of SMEs in blockchain technology can provide a massive boost not only to their own economic activity, but to the Single Market and the European economy as a whole.

Using enabling technologies to innovate, produce, and provide solutions is becoming increasingly part of every SME's business and naturally corresponds to the long-term goal of digital transformation and green transition, the so-called twin transition. SMEs are integrated into the global supply chains. Blockchain and DLT provide great solutions to existing problems regarding authenticity and the sustainability of raw materials. As such, it significantly increases trust and contributes to greening production.

On top of discussing the general involvement and approach of SMEs to blockchain technology, BlockStand specifically investigates the role of standards and the standardisation process in the promotion of blockchain technology and of its uptake by different communities including, primarily, SMEs.

This chapter of the Atlas will be based on the responses to the questionnaire given by SME responders, as well as other activities, workshops and events carried out under the BlockStand project in support or with the participation of SMEs, to gather their views and insights on their use of blockchain and their involvement in the related standardisation work.

The questionnaire covered a wide range of questions, covering areas from the adoption and involvement in blockchain, what applications of blockchain technology are more commonly used, the awareness and interaction with the EBSI community and infrastructure, as well as the awareness and involvement in standardisation work on blockchain and challenges and possible future priorities for action and implementation.

In order to investigate in detail the needs and specificities of the action of SMEs in standardisation, the questionnaire also asked additional targeted questions aimed at SME responders, in order to highlight their point of view, approach and insights. In particular, this was done via open or more qualitative questions, which allowed the respondents to more freely express their views and insights.

From a demographics standpoint, the BlockStand questionnaire gathered around 20 valid (i.e. complete or close to complete) responses from SMEs active in a variety of sectors (Digital, Cybersecurity, Financial services, Manufacturing, Tourism…). An overwhelming majority of respondents (95%) are either microenterprises (<10 employees; <2 Million Euros annual turnover) or small enterprises (<50 employees; <10 million Euros annual turnover). It is also

interesting to note how, among smaller SMEs, the role of independent experts, consultants and blockchain practitioners also emerged, particularly in cybersecurity and fintech.

As a preliminary point, the SMEs surveyed clearly highlighted the crucial importance of blockchain to their economic activity. 64% described it as "very relevant" to their activity, and 36% as "relevant", without a single respondent selecting a lower level of importance. In terms of the main benefits from the use of blockchain, SME respondents identified primarily (more than 1 response was possible):

- Security (90%)
- Decentralisation (80%)
- Privacy (50%)

50% of respondents identified themselves primarily as providers of blockchain technology, and around 20% primarily as users. The remaining 30% of respondents (mostly independent experts and consultants) did not identify under either category.

Specifically among blockchain providers, the respondents identified a wide range of customer categories, namely:

- Large companies (73%, highlighting the crucial role of SMEs in supply chains)
- Other SMEs (64%)
- Public bodies (55%)
- Independents (55%)

It is also interesting to report on the wide variety of sectors that these customers are active in, and which specific services are provided, as they include more "predictable" sectors and applications like creation and authentication of documents and contracts, fintech and cybersecurity, but also services for manufacturing sectors as varied as agri-food, textiles and Personal Protective Equipment (PPE), waste treatment and recycling.

On the other hand, the analysis of the responses in terms of blockchain applications most commonly used identifies primarily:

- Smart contracts (75%)
- Personal identity security (66%)
- IoT (36%)
- Logistics (36%)
- Money transfers/payments (27%)

An important element that emerges across the board is the maturity and level of expertise in the use of blockchain. Over 80% of respondents have used blockchain in their economic activity for over two years, and the same amount identify themselves as "advanced" or "expert" blockchain practitioners. This once again highlights the importance of an ever-greater involvement of SMEs in blockchain and blockchain standardisation, to fully harness their insights and expertise.

A further interesting area to highlight is the role and level of involvement of SMEs in European projects related to blockchain and blockchain standardisation. In fact, around 50% of respondents indicated their participation in initiatives like EBSI, StandICT and the European Innovation Council (EIC). Specifically on the EBSI initiative and community, which is also the subject of another section of this report, about 85% of SME respondents indicated that they are aware of EBSI and its activity, with around 33% of respondents being directly involved.

The respondents directly involved in EBSI participate mostly in their capacity in:

- Technological development (80%)
- Digital wallet provider (60%)
- Trusted verifier (60%)
- Issuer of verifiable credentials (40%)

The analysis of the responses in these areas clearly highlights the high level of activity, involvement and expertise of SMEs in blockchain and the importance of the technology in their economic activity. This only reinforces the need for a legislative and standardisation blockchain framework centred on the needs and specificities of SMEs.

5.2 Identified Standardisation Gaps and Needs

Blockchain standardisation is extremely important for SMEs to scale up solutions and reduce costs, as well as ensuring consistency and trust and enabling all stakeholders to implement solutions in a safer environment.

The high-level of involvement by SMEs in blockchain technology, highlighted in the previous section, is also largely maintained when it comes to standardisation, even if to a slightly lesser extent. This is however completely understandable, given the difficulty often encountered by SMEs, and particularly microenterprises, in engaging and actively participating in the standardisation process at national, European and international level.

As a general preliminary point on the level of importance of blockchain standards for SMEs, this was largely confirmed by the questionnaire respondents, as follows:

- Extremely high (7%)
- High (53%)
- Medium (16%)
- Low (13%)
- Not important (7%)

The respondents also underlined the importance of standardisation for the growth and widespread adoption of blockchain for the European industry: 47% claimed that blockchain standardisation is “very important” in this sense, and a further 27% described it as “important”, often highlighting the need for alignment and synergy between standardisation work and relevant EU legislation.

Around 60% of the SME respondents claimed to be familiar with standards related to blockchain, with a several highlighting their direct participation in standardisation work, primarily in the respective National Standardisation Bodies (NSBs) and in international standards bodies (primarily ISO/TC 307 - Blockchain and DLT), as part of the respective national delegation.

A slightly higher percentage of responders (around 67%) answered to have some awareness of standardisation work on blockchain ongoing either at national, European (primarily CEN-CLC/JTC 19) or international level (ISO/TC 307). About half of the responders that have indicated a level of awareness of ongoing standardisation work, are also directly participating in the standards-development process. The other half are rather equally distributed among responders who indicated "some knowledge, but no direct involvement" and "only general and vague knowledge".

Among the SMEs directly participating in technical committees or working groups on standardisation related to blockchain, the representation at different levels is quite homogeneous. In fact, 60% of respondents participate primarily at the national level in the respective NSB, 50% at the international level and 40% at European level.

In terms of needs for improving and expanding the participation and concrete impact of SMEs in blockchain standardisation, lack of awareness of standards and of their benefits by the industry was identified as a primary source of concern. In order to address this, 70% of respondents underlined the need for training and coaching on blockchain standardisation for blockchain users.

Several respondents highlighted the importance of training and coaching on the standardisation process at large, rather than focusing exclusively on "sectoral" blockchain standardisation and the importance of clearly communicating the economic benefits of the use of standards by industry and SMEs.

Another critical area for potential improvement highlighted by SMEs is how well do existing standards support blockchain technology. In fact, as presented below, SMEs painted a somewhat mixed picture:

In your opinion, how well do current standards support blockchain technologies:

- Very well (0%)
- Moderately well (50%)
- Neutral (22%)
- Poorly (22%)
- Very poorly (8%)

Given the importance of this issue, a follow-up qualitative question was asked to the respondents, to give them the possibility to highlight specific shortcomings or critical areas. Here, the following issues were identified (edited and condensed for clarity):

- Blockchain standardisation is still at a relatively early stage of its development. While blockchain standardisation will become more and more important in the future, it might still be too soon to "standardise aggressively".

- Insufficient emphasis on the interoperability between different blockchain technologies.
- Definition of actual decentralisation: once the word "blockchain" is said, many projects or implementation are de facto centralised (single point of access to the DLT, unique infrastructure, all nodes hosted by a single actor, etc). That sort of de facto centralisation, often marketing-driven, breaks all promises of DLT, and creates confusion on the market.
- Integrity of data.
- Lack of alignment/synergy between blockchain standards and cybersecurity standards.
- ISO/TS 23635:2022 "Blockchain and distributed ledger technologies Guidelines for governance" is a good document which proposes a methodology to support the deployment of blockchain projects which considers the theme of the consensus algorithm. Other avenues linked to the theme of consensus could be promoted, for example a use case approach. The consensus algorithm corresponds to the network level, the maturity of which is essential in order to be able to consolidate the application part in a solid manner. Scientific research is active in this area.

While the issue of access and participation for SMEs in standardisation remains, the results of the questionnaire show an active community of SMEs recognising the importance of blockchain standardisation to the development of the technology and to its uptake by more and more SMEs and economic operators. Furthermore, a relatively high number of respondents highlighted their direct participation in the development of blockchain standards and gave strong, concrete indications for further improvements.

5.3 Challenges for Adopting Blockchain Technologies and Standards

Another area of analysis among SMEs concerns the challenges for wider uptake and adoption of blockchain technology, and of related standardisation work.

As a more general and “policy-oriented” question, a few main challenges emerge insistently from our analysis:

- Interoperability and “integration” issues. Shortcomings in these areas remain the biggest obstacles towards cross-country and cross-sector transactions for SMEs. Interoperability is crucial to eliminate or reduce vendor lock-in, which is important for SMEs who want to provide blockchain-based services in any sector.
- Uncertain alignment and synergy between the regulatory framework and the related standardisation work.
- Level of awareness of blockchain technology among SMEs that still has to improve.

In particular, on this last point, over 70% of respondents believe that it’s necessary to particularly address needs and specificities of SME involvement in blockchain (50% agree, 20% strongly agree), in order to improve awareness and, consequently, uptake of the technology.

In order to have a clearer picture of the priorities and challenges facing SMEs involved in blockchain and their customers, the respondents were asked a specific open, qualitative question on the matter (responses edited and condensed for clarity):

Which are the main blockchain needs, challenges and priorities in dealing with your customers?

- Lack of awareness and understanding of blockchain on the customer side, which impact costs and speed of response by the SME providers.
- Need to improve control, compliance, sourcing origin, fraud detection and transparency.
- Traceability, privacy and (cyber)security concerns.
- Level of awareness of blockchain technology among SMEs that still has to improve.
- At times, supporting customers in complying with relevant policies and legislation.

Bridging the gap between use of blockchain technology and uptake of the related standards can be difficult for SMEs. In order to address this gap and identify the areas where standardisation could provide the most added value, the questionnaire asked a series of targeted questions on these subjects:

What specific issues have you encountered while using or providing blockchain technology that you believe could be addressed through standardisation?

- Fragmentation (36%)
- Complexity of relevant regulation and/or technical specifications (15%)
- Accessibility (15%)
- Training/lack of capable personnel (15%)

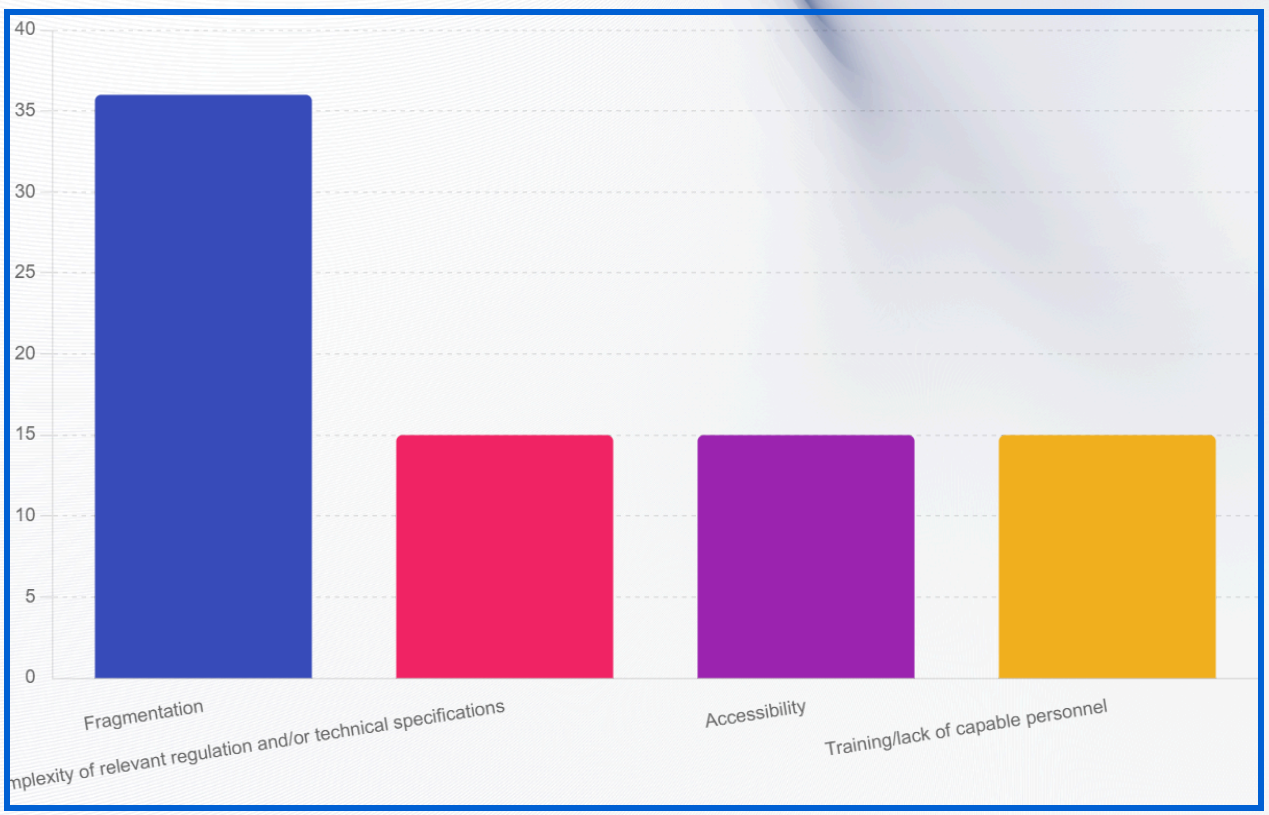

Figure 8: SMEs: Issues in Blockchain Technology that could be addressed through Standardisation

As we can see from the list above, this is a wide range of topics to tackle for an SME. In order to address these challenges, one of the main solutions proposed was a focus on coaching and training initiatives to boost awareness and knowledge of blockchain among SMEs. In fact, when the respondents were asked whether they agree that there is a need for targeted training and coaching on blockchain (and blockchain standardisation) among SMEs and blockchain technology users, these were the results:

- Strongly agree (27%)
- Agree (43%)
- Neutral (21%)
- Disagree (8%)

Some interesting further notes were received also when discussing the possible scope of said coaching and training. For instance, several respondents underlined the importance of providing having "general" scope and objectives in terms of standardisation coaching, and not focusing exclusively on blockchain standardisation. A particular focus should also be on the "business case" for standardisation and on highlighting the added value of standards in terms of improving ease of use and interoperable solutions to help SMEs meet their needs.

In order to go more in depth on the issue of the possible value added of blockchain standardisation, and gather tangible examples, the respondents were also asked a related open qualitative question (responses edited and condensed for clarity):

What do you think are the main challenges to the widespread use of standards related to blockchain?

- Lead the harmonisation and interoperability of different blockchain technologies.
- Strong use cases, regulatory references, more detailed and useful standards.
- Correctly address the timing of the development of standards and correctly state and incorporate the level of technology development/state of the art.
- Maturity of standards and of the blockchain industry as a whole. Understanding that blockchain cannot just operate by itself, but needs to integrate with different technologies, policies and legislation. Avoid a proliferation of standards and do not publish too many new documents too quickly. Rather, wait to receive feedback on the use of the first published standards. Users of standards need a learning phase in order to appropriate the methods described in the standards.
- Lack of understanding of real-life use cases. Companies don't see applicability and business use cases yet.
- Improve the final user understanding.
- False decentralisation: "private" blockchain, centralised access, or centralised infrastructure should be differentiated from actual DLT.
- Draft very “simple” standards and focus on widespread adoption at this stage. For instance ERC-20 is a very good example: very simple, yet creating many possibilities.

Once again, the responses show a very proactive community of SMEs, well aware of the issues at hand and willing to offer detailed and constructive analysis and suggestions for improvement.

5.4 Policy & Standardisation Recommendations

The last area of this chapter, linked to the targeted SMEs participation in the questionnaire, concerns recommendations. While certain elements of suggestions for next steps in adoption of blockchain technology and standards have already emerged in the previous, particularly in the more qualitative answer, this final section aims at offering a broader overview.

As mentioned also at the beginning of the previous section, interoperability and integration issues are at the top of the list of wishes and recommendations expressed by the participating SMEs. Another point of great emphasis is the alignment and SME friendliness of legislation, particularly at European level, that can impact blockchain technology and its different applications.

In this sense, the questionnaire investigated specifically the level of knowledge and understanding among SMEs of the eIDAS 2 Regulation and of the Data Act.

Regarding eIDAS 2, the responses were very encouraging, with around 75% of interviewed SMEs claiming at least a good level of knowledge and active monitoring of the proposal (please note, the questionnaire was carried out before the final eIDAS 2 Regulation was passed in spring 2024).

On the Data Act, the figures are lower, with around 60% of respondents claiming awareness of the (then newly passed) legislation, but many stating that more detailed knowledge and analysis of its provisions would be needed on their part.

In terms of recommendations for other EU activity and initiatives in support of blockchain, particularly EBSI, a specific open question was asked concerning recommendations from SMEs for future EBSI test cases to be promoted and/or areas where the EBSI should enhance its action. The main recommendations are listed here below (edited and condensed for clarity):

- Improve security and pursue closer alignment with standardisation.
- Trusted data sharing.
- Provide a cloud wallet available via API as a wallet platform as a base for other products that involve verifiable credentials.
- Employment Payments/Banking/Finance.
- Travel and Financial services.

In terms of recommendations to improve awareness, skills and transfer of knowledge on blockchain technology by users and SMEs, the respondents outlined a wide range of possible initiatives (more than 1 option could be indicated):

- Dissemination of use cases and best practices - 64%
- Manuals and Guides - 50%
- Short/Targeted training courses - 43%
- Simplify technical content - 36%
- Seminars - 36%

As it is evident from these responses, while the emphasis in terms of recommendations seems to be on initiatives aimed at boosting a practical, hands-on approach and real-life use cases, there is no silver bullet, but on the contrary a wider set of initiatives are recommended.

Finally, a series of detailed questions were asked to gather recommendations on how standards and standardisation development can support the uptake and expansion of blockchain technology.

First off, from a more general or “methodological” standpoint, a question was asked on which approach should be prioritised for standardisation work on blockchain. This question did not give a definitive answer, perhaps highlighting again the less than full maturity of blockchain standardisation, or possibly the need to avoid prioritising a unique approach.

In fact, the responses were the following:

- Prioritise industry/sector specific standards - 36%
- Prioritise horizontal standards - 28%
- Do not know/Not sure - 36%

The questionnaire also investigated which actions are recommended to be pursued to raise awareness and increase the participation of SMEs to the development of blockchain standards, the emphasis was once again on concrete applications, as seen here below:

- Use cases 71%
- Best practices 57%
- Events 57%
- Easier access to standardisation bodies 43%
- Financial support for SMEs 15%

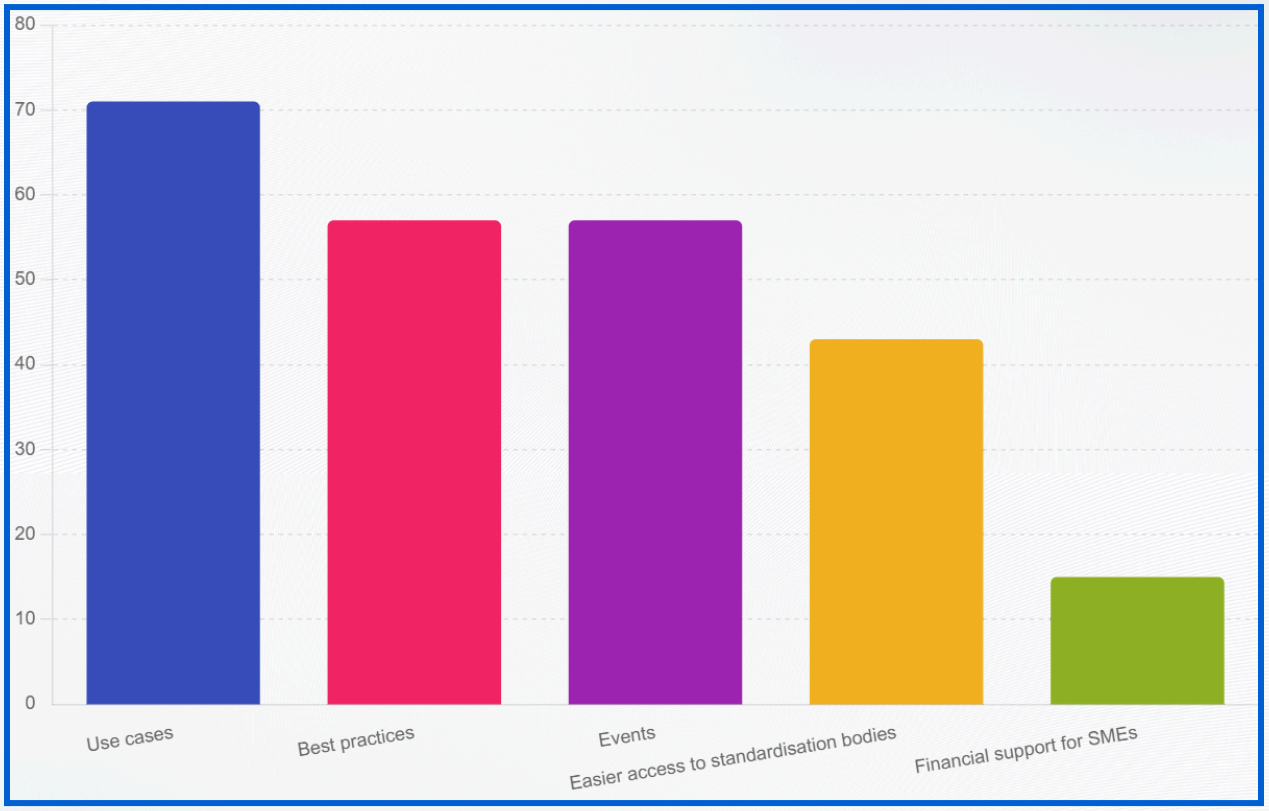

Figure 8: SMEs: Recommended actions to raise awareness and increase the participation of SMEs in the development of blockchain standards.

As a follow-up question SMEs were asked what in their opinion are the most essential initiatives for companies and organisations to effectively contribute to shaping blockchain standards, once they are active and involved in the standardisation process? (a maximum of two choices could be submitted)

- Collaborative Platforms (Industry associations, Blockchain communities) - 72%
- Technical support and training in blockchain - 72%
- Coaching on standardisation - 36%

- Financial support - 36%
- Direct, unimpeded access to Standards Development Organisations - 36%

Notably, for SMEs involved in blockchain standardisation, the most impactful way of effectively participating in the drafting of standards seems to be capacity building and a closer collaboration with other blockchain practitioners, rather than focusing on forms of public or private financial or HR support.

Furthermore, a general question was asked on which of the main challenges affecting the blockchain industry would be better or more impactfully addressed by standardisation work. Unsurprising, as it has been a common theme throughout the responses submitted by SMEs across the whole questionnaire, interoperability was once again identified as the top concern and area for action. Here below the top areas identified (a maximum of two choices could be submitted):

- Interoperability - 78%
- Technical implementation of technology - 50%
- Specific definitions or requirements - 50%
- Innovation or new use cases - 29%

As a final point, once again linking the necessity for alignment between policy, regulation and standardisation to support and boost the expansion and uptake of blockchain among SMEs, the following top recommendations and priorities were outlined in terms of blockchain standardisation in support of existing or upcoming EU legislation:

- EU Digital Identity/Wallet - 46%
- Smart contracts (including link to Data Act) - 46%
- Qualified seals and e-signatures - 38%
- Conformity with eIDAS regulation / eIDAS 2 electronic ledger trust service - 23%
- Interoperability between blockchain networks and legacy systems - 15%

6 CONCLUSION

6.1 The International Blockchain Standardisation Landscape

The international blockchain and DLT standardisation landscape is crucial for ensuring global interoperability and collaboration across various applications and sectors. The establishment of industry standards is essential not only for enterprises but also for governments, financial institutions, and technology developers. Numerous publications from various national and international standards organisations and industry consortia, complemented by 113 working groups have addressed different aspects of DLT. This trend reflects a broadening scope and increasing depth in standardisation efforts, offering new insights and highlighting areas that require further development.

The organisations below play a significant role in DLT standardisation:

a. **International Organization for standardisation (ISO)**
   - **ISO/TC 307**: Since 2016, with 12 working groups and 11 publications, it has 5 DLT-related standards in development.
   - Other ISO committees also contribute to DLT standards.

b. **ITU Telecommunication standardisation Sector (ITU-T)**
   - Produced 28 publications through four focus groups and two study groups.

c. **European Committee for Electrotechnical standardisation (CENELEC)**
   - Active in decentralised identity management under JTC 19.

d. **European Telecommunications Standards Institute (ETSI)**
   - ISG Permissioned Distributed Ledger (PDL) has 15 publications, including contributions from IPv6-focused groups.

e. **American National Standards Institute (ANSI)**
   - Accredited Standards Committee (ASC) X9 has standards and technical reports related to financial services.

f. **National Institute of Standards and Technology (NIST)**
   - Published reports and a white paper involving three working groups.

g. **Asociación Española de Normalización (UNE)**
   - SC 307 group has one published standard on DLT.

h. **Deutsches Institut für Normung (DIN)**
   - Published five DLT specifications and one pre-standard.

i. **Institute of Electrical and Electronics Engineers (IEEE)**
   - Various committees focus on blockchain and DLT standards.

j. **International Token standardisation Association (ITSA)**
   - Established three working groups for token standards.

k. **International Association for Trusted Blockchain Applications (INATBA)**
   - Hosts six working groups and one Standards Committee.

l. **Internet Engineering Task Force (IETF)**
   - Focuses on secure asset transfer protocols.

m. **European Blockchain Association (EBA)**
   - Coordinates European blockchain activities with several active and planned working groups.

n. **Blockchain Australia**
   - Engages in government consultations with three active working groups.

o. **Enterprise Ethereum Alliance (EEA)**
   - Focuses on Ethereum business acceleration with six working groups.

It is clear that the landscape of DLT publications is characterised by robust and diversified efforts from a range of standardisation bodies and industry groups. With 95 publications and 113 working groups actively contributing to the field, there is a clear and concerted push towards enhancing DLT standards across various domains. These developments illustrate a growing recognition of the need for unified protocols and guidelines to address the complexities and opportunities presented by DLT technologies. While progress is evident, the field continues to evolve, requiring ongoing collaboration and adaptation to ensure that standards keep pace with technological advancements and industry needs. As DLT continues to mature, the collective efforts of these organisations will be crucial in establishing a cohesive framework that supports innovation and interoperability on a global scale.

6.2 Gaps and Mismatches in the EU Blockchain Standardisation Landscape

The analysis of the questionnaire responses, interviews and associated meetings reveals several significant gaps and mismatches in the current EU blockchain standardisation landscape. One of the most critical gaps is in interoperability, with 75.68% of respondents identifying the need for standards that enable seamless integration between different blockchain systems and legacy technologies. This lack of interoperability hinders the scalability and broader adoption of blockchain solutions.

Another major gap is the shortage of skilled personnel, highlighted by 81.82% of respondents. The complexity of blockchain technologies demands highly specialised skills, which are currently in short supply, leading to difficulties in implementing and maintaining blockchain systems effectively.

Technical complexity is also a notable barrier, with 45,45% of respondents citing it as a significant issue. The need for more user-friendly and practical standards is apparent, as complex technical requirements can deter smaller enterprises and organisations with less technical expertise from adopting blockchain technologies.

Cost considerations are another critical challenge, especially for SMEs. High implementation and maintenance costs can be prohibitive, limiting the accessibility of blockchain solutions to larger, more well-resourced organisations.

Furthermore, there are mismatches in the standardisation needs across different sectors. While cross-industry standards are essential, there is a clear demand for sector-specific standards to address the unique challenges and requirements of various industries such as digital finance, cybersecurity, and consulting-related services.

6.3 Policy & Standardisation Recommendations

To address these identified gaps and mismatches, several policy and standardisation recommendations are proposed to EU policymakers, public bodies, educational institutions, EU and international SDOs, and industry professionals:

1. Enhance Interoperability Standards

Develop and promote standards that facilitate seamless interaction between different blockchain systems and legacy technologies. This includes common protocols and interfaces to ensure compatibility and interoperability across platforms. Develop cross-industry and cross-sector blockchain standards to enhance interoperability and seamless integration across diverse applications. Examples of (non-)legislative initiatives already addressing this issue across various sectors, which might affect blockchain applications as well, include the eIDAS 2 Regulation for digital EU identity, Digital Operational Resilience Act for digital operational resilience across European financial entities, or the European Strategy for Data, including such regulations as General Data Protection Regulation and Data Act.

2. Address the Skills Gap

Implement targeted training programs and certifications to build expertise in blockchain standardisation. Collaborate with educational institutions to integrate blockchain and standardisation courses into their curricula and support continuous professional development initiatives. Develop specialised educational and training programs, including workshops, seminars and courses, tailored to enhance practical skills and prepare stakeholders for active participation in standardisation efforts. Industry-academia collaboration should be leveraged to produce up-to-date curricula and training modules aligned with real-world blockchain challenges and industry needs. While there is currently no initiative that would deal with blockchain skills and standardisation at the same time, there are initiatives that tackle the topic of blockchain skills shortages and mismatches, providing tools and libraries to ensure a skilled workforce and streamline blockchain-related educational processes (e.g. the Erasmus+ project CHAISE: Blockchain Skills for Europe), while other initiatives that develop standards for blockchain (mentioned throughout the document) provide tools (e.g. workshops or seminars) to support professional development.

3. Simplify Technical Standards

Create more user-friendly and implementable standards to reduce the technical complexity of blockchain systems, making blockchain technologies more accessible to smaller enterprises and less technically proficient organisations. As an example, ERC standard development process is simpler due to its open, collaborative, and iterative nature, allowing for rapid proposal, review, approval, and implementation. In contrast, the SDOs process involves formal procedures, extensive documentation, and slow, bureaucratic steps, making it more complex and time-consuming. Examples of (non-)legislative initiatives addressing this topic, which might affect blockchain applications as well, include the General Data Protection Regulation, setting common EU requirements for data privacy and security, the EU Cybersecurity Act, establishing a cybersecurity certification framework for products and services, or the World Wide Web Consortium, contributing to simplifying standards for web-based blockchain applications.

4. Support Cost-Effective Solutions

Develop standards that focus on cost-effectiveness to ensure blockchain solutions are affordable for SMEs. Promote open-source solutions and encourage the development of low-cost blockchain implementations. As stated by the questionnaire responses 45,5% refer to cost as a challenge for involvement in Blockchain. Initiatives like the European Innovation Council, Digital Europe Programme, Horizon Europe, Connecting Europe Facility, the Recovery and Resilience Facility, or European Digital Innovation Hubs might be possible avenues to seek funding.

5. Prioritise the development of cross-industry standards (while addressing specific-industry needs)

Cross-industry standards ensure broad applicability and interoperability. Given the rapid evolution of blockchain technology, horizontal standards provide a stable foundation for innovation. This approach should include a component-based architecture that focuses on standardising behavioural APIs and defining functional and security properties of system/infrastructure components. However, sector-specific considerations should be integrated to tackle particular technical challenges without fragmenting the standardisation efforts.

6. Increase Awareness and Participation through Funding

Enhance the dissemination of information about standardisation efforts through workshops, webinars, and industry conferences. Encourage broader participation in standardisation bodies to ensure diverse input and engagement. Increase funding through targeted grants and financial incentives to bolster research and development in blockchain technology and standardisation.

7. Regulatory Alignment and Support

Provide clear guidelines and support for regulatory compliance. Work closely with national regulatory bodies to ensure blockchain standards align with existing laws and policies, facilitating easier compliance for organisations, the European Blockchain Regulatory Sandbox being a good and successful example, that needs to be extended in time and scope.

6.4 Blockchain Standardisation Future Trends and Outlook

Looking ahead, several trends and developments are likely to shape the future of blockchain standardisation in Europe. These reflections, as highlighted by INATBA's continuous monitoring, conducted across a variety of activities involving the public sector (Governmental Advisory Body meetings, Task Forces, bilateral discussions and workshops, Working Groups activities, liaison activities with standards setting bodies), underscore the importance of ongoing efforts in this field. BlockStand, through the work of selected standardisation experts, is already addressing some of these critical topics. Future candidates will be further incentivised to contribute to standardisation efforts in these emerging areas.

1. Greater Emphasis on Interoperability

There will be an increased focus on developing standards that enhance interoperability, crucial for enabling seamless integration and interaction between different blockchain platforms and legacy systems. This aligns with the European Commission's Digital Strategy and the European Interoperability Framework.

2. Expansion of Decentralised Finance (DeFi)

The growth of DeFi will drive the need for robust standards that ensure security, transparency, and regulatory compliance. Standards will need to address the unique challenges posed by decentralised financial systems. INATBA has been working on a self-regulatory framework for DeFi that will be presented in Q4 of 2024. This work complements the European Securities and Markets Authority guidelines on crypto-assets and the EU's comprehensive Markets in Crypto-Assets Regulation.

3. Integration with Emerging Technologies

Blockchain will increasingly integrate with other emerging technologies such as artificial intelligence (AI), Internet of Things (IoT), and quantum computing, necessitating new standards that address the combined complexities and capabilities of these technologies. This development supports the EU's Horizon Europe programme, which promotes the integration of advanced technologies.

4. Focus on Sustainability

Environmental sustainability will become a key consideration in blockchain standardisation, with standards promoting energy-efficient practices and supporting the EU's Green Deal objectives.

5. Enhanced Security and Privacy

With evolving cyber threats, there will be a heightened focus on developing standards that enhance the security and privacy of blockchain systems, including advanced cryptographic techniques and robust data protection measures. These standards shall align with the EU's General Data Protection Regulation and the Network and Information Systems (NIS2) Directive.

6. Increased Regulatory Involvement

Regulatory bodies need to play a more active role in shaping blockchain standards, ensuring alignment with legal and policy frameworks, which will help build trust and confidence in blockchain technologies. This is supported by the recent establishment of the EUROPEUM-EDIC.

7. Broader Industry Adoption

As standards mature and become widely adopted, a broader range of industries (e.g. supply chains, logistics, financial service, healthcare, public services, real estate) will implement blockchain solutions, driving further innovation and standardisation efforts, creating a virtuous cycle of development and adoption. This adoption is evidenced by industry participation in standardisation bodies, real-world implementations by major corporations, and government initiatives. Successful case studies, compliance certifications, and the integration of standardised protocols into technology solutions further indicate widespread adoption. Additionally, industry reports and endorsements from leading organisations highlight the practical use and impact of these standards.

8. Tokenisation of Real-World Assets (Financial and Non-Financial)

The tokenisation of real-world assets, including both financial assets like stocks and bonds, and non-financial assets like real estate and commodities, will necessitate the development of standards to ensure the secure, transparent, and efficient representation of these assets on blockchain platforms. This aligns with the European Commission's activities to follow new trends impacting regulated sectors.

9. Decentralised Autonomous Organisations (DAOs)

As DAOs, future digital Cooperatives, become more prevalent, there will be a need for standards that address their governance, legal recognition, and operational frameworks. These standards will help in defining best practices, ensuring regulatory compliance, and fostering trust in these innovative organisational structures. This proactive approach ensures that emerging trends are addressed promptly and effectively, fostering a robust and adaptive blockchain standardisation framework.

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In conclusion, BlockStand maintains that the future of blockchain standardisation in Europe is poised for significant growth and development. The Atlas, grounded in BlockStand's comprehensive tasks of mapping ongoing blockchain standardisation activities, analysing the needs and recommendations for EBSI, engaging R&I community, and supporting SMEs, along with maintaining an online repository of blockchain standardisation activities, provides a detailed overview of the current landscape and actionable steps forward.

The Atlas highlights critical gaps and mismatches in blockchain standardisation and offers targeted, comprehensive and actionable policy and standardisation recommendations tailored to the needs of key stakeholders: EBSI, the R&I community, and SMEs. Beyond these stakeholder-specific recommendations, it emphasises the need for improved coordination among stakeholders, enhanced legal and social acceptance of blockchain, and its integration into regulatory frameworks.

By supporting and coordinating EU standardisation experts, BlockStand aims to solidify European leadership in blockchain standardisation. The outputs of the project, including this Atlas, serve as cornerstone references to achieve these goals. By addressing the current gaps and mismatches, implementing targeted recommendations, and staying attuned to emerging trends,

the EU can foster a robust, interoperable, and secure blockchain ecosystem that supports innovation and economic growth.

APPENDICES

Resources and References

BlockStand Needs & Recommendations Questionnaire – Complete responses

1. European Blockchain Partnership. (n.d.). [https://digital-strategy.ec.europa.eu/en/policies/blockchain-partnership]
2. Digital Programme. (n.d.). [https://digital-strategy.ec.europa.eu/en/activities/digital-programme]
3. European Blockchain Pre-Commercial Procurement. (n.d.). [https://digital-strategy.ec.europa.eu/en/news/european-blockchain-pre-commercial-procurement]
4. Verifiable Credentials Success Stories. (n.d.). [https://ec.europa.eu/digital-building-blocks/sites/display/EBSI/Verifiable+Credentials+Success+Stories]
5. European countries join Blockchain Partnership | Shaping Europe's digital future. (n.d.). [https://digital-strategy.ec.europa.eu/en/news/european-countries-join-blockchain-partnership]
6. Information about tools, libraries and APIs. (n.d.). [[https://hub.ebsi.eu/]
7. List of EBP representatives. (n.d.). [https://ec.europa.eu/digital-building-blocks/sites/display/EBSI/List+of+EBP+representatives]
8. Belgium to focus on public sector European blockchain during its EU presidency. (2023, November). [https://sciencebusiness.net/news/ict/belgium-focus-public-sector-european-blockchain-during-its-eu-presidency]
9. New EU instrument aims to foster collaboration in digital infrastructure. (n.d.). [https://sciencebusiness.net/news/ict/new-eu-instrument-aims-foster-collaboration-digital-infrastructure]
10. European Blockchain Observatory and Forum [https://blockchain-observatory.ec.europa.eu/document/download/fd34e357-3b74-4d39-a54d-b09f3491ab4b_en?filename=EU_Blockchain_Ecosystem_Developments_3.0.pdf]
11. EU Consortia in focus: Exploring Global Trends in Industrial Blockchain Projects [https://inatba.org/wp-content/uploads/2024/07/Industrial-Blockchain-Task-Force-Report-July-2024.pdf]
12. eIDAS Regulation. (n.d.). [https://digital-strategy.ec.europa.eu/en/policies/eidas-regulation]
13. Digital Operational Resilience Act. (n.d.). [https://www.esma.europa.eu/esmas-activities/digital-finance-and-innovation/digital-operational-resilience-act-dora]
14. A European strategy for data. (n.d.). [https://digital-strategy.ec.europa.eu/en/policies/strategy-data]
15. Data protection. (n.d.). [https://commission.europa.eu/law/law-topic/data-protection_en]
16. Data Act. (n.d.). [https://digital-strategy.ec.europa.eu/en/policies/data-act]
17. CHAISE Blockchain Skills for Europe. (n.d.). [https://chaise-blockchainskills.eu/]
18. The EU Cybersecurity Act. (n.d.). [https://digital-strategy.ec.europa.eu/en/policies/cybersecurity-act]
19. World Wide Web Consortium. (n.d.). [https://www.w3.org/]
20. European Innovation Council. (n.d.). [https://eic.ec.europa.eu/index_en]
21. Horizon Europe. (n.d.). [https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en]

22. Connecting Europe Facility. (n.d.). [https://hadea.ec.europa.eu/programmes/connecting-europe-facility_en]
23. The Recovery and Resilience Facility. (n.d.) [https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility_en]
24. European Digital Innovation Hubs. (n.d.). [https://digital-strategy.ec.europa.eu/en/activities/edihs]
25. INATBA Governmental Advisory Body. (n.d.). [https://inatba.org/gab-members/]
26. Shaping Europe's digital future. (n.d.). [https://digital-strategy.ec.europa.eu/en]
27. New European Interoperability Framework. (2017). [https://ec.europa.eu/isa2/sites/default/files/eif_brochure_final.pdf]
28. ESAs consult on Guidelines under the Markets in Crypto-Assets Regulation. (2024, July 12). [https://www.esma.europa.eu/press-news/esma-news/esas-consult-guidelines-under-markets-crypto-assets-regulation]
29. Markets in Crypto-Assets Regulation. (2023, June 9). [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023R1114]
30. The European Green Deal. (n.d.). [https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en]
31. Directive on measures for a high common level of cybersecurity across the Union (NIS2 Directive). (n.d.). [https://digital-strategy.ec.europa.eu/en/policies/nis2-directive]
32. Blockchain: Creation of EUROPEUM-EDIC. (2024, May 22). [https://digital-strategy.ec.europa.eu/en/news/blockchain-creation-europeum-edic]
33. Workshop on asset tokenisation. (2024, June 11). [https://finance.ec.europa.eu/events/workshop-asset-tokenisation-2024-06-11_en]
34. ITU-T Technical Report FG DLT D1.3: Distributed ledger technology standardization landscape. (2019, August 1). [https://www.itu.int/en/ITU-T/focusgroups/dlt/Documents/d13.pdf]
35. ETSI Report: Permissioned Distributed Ledger (PDL); Landscape of Standards and Technologies. (2020, March). [https://www.etsi.org/deliver/etsi_gr/PDL/001_099/001/01.01.01_60/gr_PDL001v010101p.pdf]
36. INATBA Report: Systematisation of Knowledge: Distributed Ledger Technology Standardisation. (2024, February). [https://inatba.org/reports/dlt-standardisation-a-comprehensive-report-on-current-efforts-and-future-directions/]

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