A Holistic Digital Mine 4.0 Ecosystem

D7.3
Mine.io Outreach, dissemination, standardisation and communication activities - v1

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Abstract	This deliverable presents initial progress of the Outreach, Communication, Dissemination and Standardisation activities for period M1-M21.
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Executive Summary

The deliverable D7.3 v1 aims to provide an initial report about Outreach, Communication, Dissemination and Standardisation activities. This document covers the efforts from month M1 to M21. It emphasizes maximizing the impact and visibility of the Mine.io results through dissemination and communication. The deliverable build upon including their scope, targets and results during this period followed by the next steps.

Ł-ITR coordinated outreach, communication, and dissemination activities, together with project partners by actively participating in key conferences, workshops, and events. Their goal was to promote the Mine.io objectives, technologies, and intended impacts, as detailed in the report. The detailed report on their contribution and achievement has been described here.

The report on the standards survey, its results and list of the identified standards specific to the Mine.io project along with next development in context with standard validation presented in the standardisation section managed by Jotne. The project active involvement in the collaboration with cluster projects 'Smart Ecomine hub' [10] to collect the insights related to Standardisation also highlighted.

The successful outcome of the first awareness campaign organized by GFT, their plan for next ones in October and websites design are some of the key achievements detailed out in this deliverable.

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Terms and Abbreviations

AG	Advisory Generation
AP	Application Protocol
AaaS	Analytics as a service
BPMN	Business Process Model and Notation
CAD	Computer-aided design
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
DA	Data Acquisition
DM	Data Manipulation
DUST	Dual Use Science and Technology
EASA	European Union Aviation Safety Agency
EIP	Ethereum Improvement Proposals
EN	European Norm
ERC	Ethereum Request for Comments
ETSI	European Telecommunications Standards Institute
EU	European Union
EVR	Electric Vehicle Road
GDPR	General Data Protection Regulation
HA	Health Assessment
IC	Integrated Circuit
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IIoT	Industrial internet of things
ISO	International Organization for Standardization
LUC	Light UAS operator Certificate
IPMS	International Post Mining Symposium
KPI	Key Performance Indicators
MIMOSA	Open Standards for Physical Asset Management
MQTT	Message Queuing Telemetry Transport
OSA-CBM	Open System Architecture for Condition-Based Maintenance
PA	Prognostics Assessment
PDAC	Prospectors & Developers Association of Canada
PLM	Product Lifecycle Management
PU	Public
SAE	Society of Automotive Engineers
SAFA	Safety Assessment of Foreign Aircraft
SC	Subcommittee
SD	State Detection
SDO	Standards Developing Organization
STEP	Standard for the Exchange of Product model data
TC	Technical Committee
TEU	Treaty on European Union

UAS	Unmanned Aircraft Systems
UAV	Unmanned Aircraft Vehicles
UML	Unified Modeling Language
WLAN	Wireless Local Area Network
WP	Work Packages
WPT	Wireless Power Transfer

1 INTRODUCTION

1.1 DOCUMENT STRUCTURE

This deliverable provides a concise overview of the communication, dissemination, outreach activities in the section 2, and standardization actions in the section 3 from period M1 to M21. It outlines strategies for the effective communication, visibility, and the information of results. Specifically, it covers aspects such as clear messaging, target audiences, and milestone delivery with respect to above topics.

1.2 RELATION TO OTHER WPS/TASKS

The D7.3 mark out relation with the tasks involved in the WP7, WP2 and WP5. Below table show the list of tasks and WPs:

Work Package	**Task**	**Relation**
WP2	T2.6	Inventory list collected list of Standards used in this project
WP5	T5.7	Development of Standards based ISO 10303 Repository
WP5	T5.1	Development of Workflow Automation Engine using BPMN v2.0
WP7	T7.1	Market Understanding from the communication and outreach.
WP7	T7.2	Business model and uptake roadmap
WP7	T7.3	Dissemination and Communication Plan
WP7	T7.4	Awareness Campaigns
WP7	T7.5	Standardisation activities

2 MINE.IO OUTREACH, DISSEMINATION AND COMMUNICATION

2.1 SOCIAL MEDIA

Mine.io has strategically developed a presence across multiple social media platforms, including LinkedIn, X (formerly Twitter), Facebook, and YouTube, to effectively communicate our project's progress, engage with diverse audiences, and expand our outreach. Each platform serves a unique purpose in our overall communication strategy, ensuring that we reach both industry professionals and the general public with relevant and timely updates.

As part of our objectives, we are tasked with achieving various Key Performance Indicators (KPIs), including, among others, publishing 200 posts annually across our social media channels and meeting specific viewership targets on YouTube. We are actively working to meet these goals, continuously refining our content and engagement strategies to ensure their successful achievement.

Our campaigns are being carried out on our social media platforms in the following format:

2023:

- About partners (LD)
- Invitation to Workshop No.1 (LD, X, FB)
- Summary of Workshop No.1 (objectives, impact on different areas LD/X/FB)

2024:

- Summary of Workshop No.1 (video of each session X/LD/FB/YT)
- About Project 2 (use case/technologies/pilots/social impact/LD/FB)

2.1.1. Facebook

The Mine.io Facebook page was launched in December 2023 to engage a broader audience beyond the technical and industry-focused communities. This platform aims to share our achievements with the general public and raise awareness about the Mine.io project. Although our primary focus has been on expanding our presence on LinkedIn, we are committed to steadily improving our Facebook page. We regularly post updates on project milestones and events, ensuring that our followers stay informed. Despite being in its early stages, our Facebook page has already garnered 29 followers, and we are continually working to expand our reach and grow our community. The number of posts on the Mine.io FB channel in the period M1-M21 is 74.

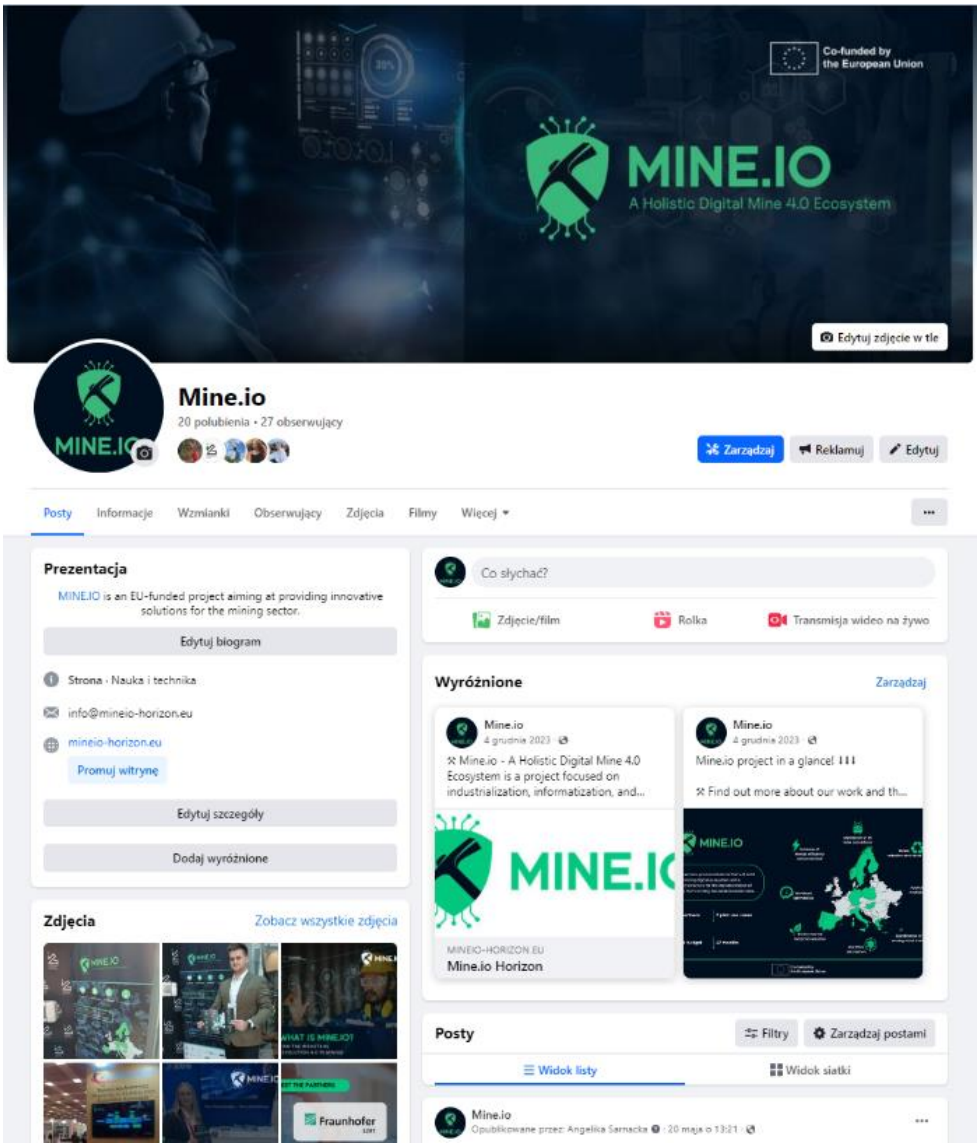

Figure 1 MINE.IO Facebook page

2.1.2. X

The Mine.io project initially established its presence on Twitter (now X) in May 2023, where we regularly shared updates and content related to our activities and events: https://x.com/mineio_horizon. Unfortunately, due to technical issues with our official project email account (info@mineio-horizon.eu), access to this Twitter account was lost. Despite numerous attempts to recover it, we were unable to regain control.

As a result, we were compelled to create a new profile, which was launched in October 2023. From that point onward, all updates and official communications have been published on our new Twitter account: https://x.com/mineio_project. This is now the official profile for the Mine.io project. The new X Mine.io channel as of September 2024 has 98 followers. In 2023, we published 108 posts on X, while in 2024, we published 19 posts on the new channel and are continuing.

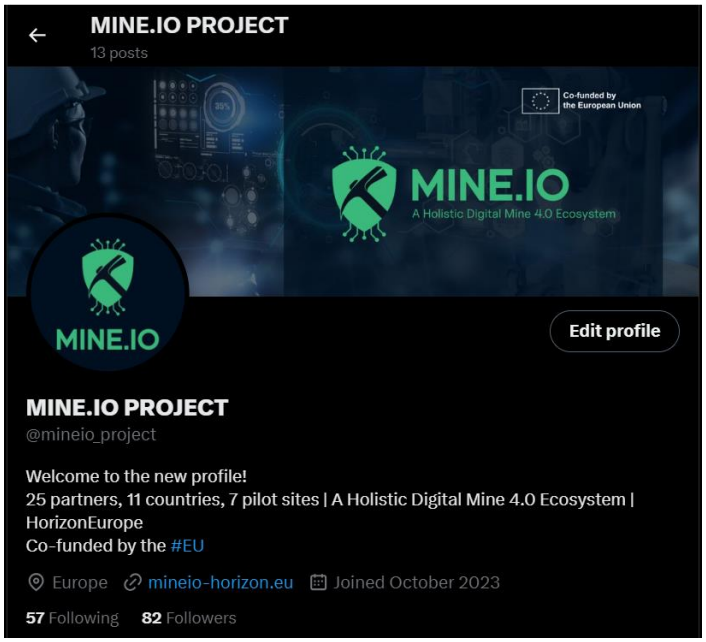

Figure 2 Current MINE.IO X page

2.1.3. LinkedIn

LinkedIn serves as the primary channel for Mine.io's outreach, dissemination, and communication efforts, providing an effective platform to engage with engineers and industry specialists. Our LinkedIn page has rapidly grown to become our most powerful communication tool.

As of the beginning of 2023, the Mine.io LinkedIn page boasts a following of 364 professionals. Established in early 2023, our posts have achieved significant visibility and engagement over the past year, garnering 49,000 views and 1,600 reactions. This demonstrates the success of our strategic focus on LinkedIn to reach and connect with key stakeholders in the mining sector. The number of posts on the Mine.io LD channel in the period M1-M21 is 157.

Our content strategy on LinkedIn includes regular updates on project milestones, insights into industry trends, and interactive posts designed to foster community engagement and knowledge sharing. This approach has not only increased our visibility but also established Mine.io as a thought leader in the mining industry.

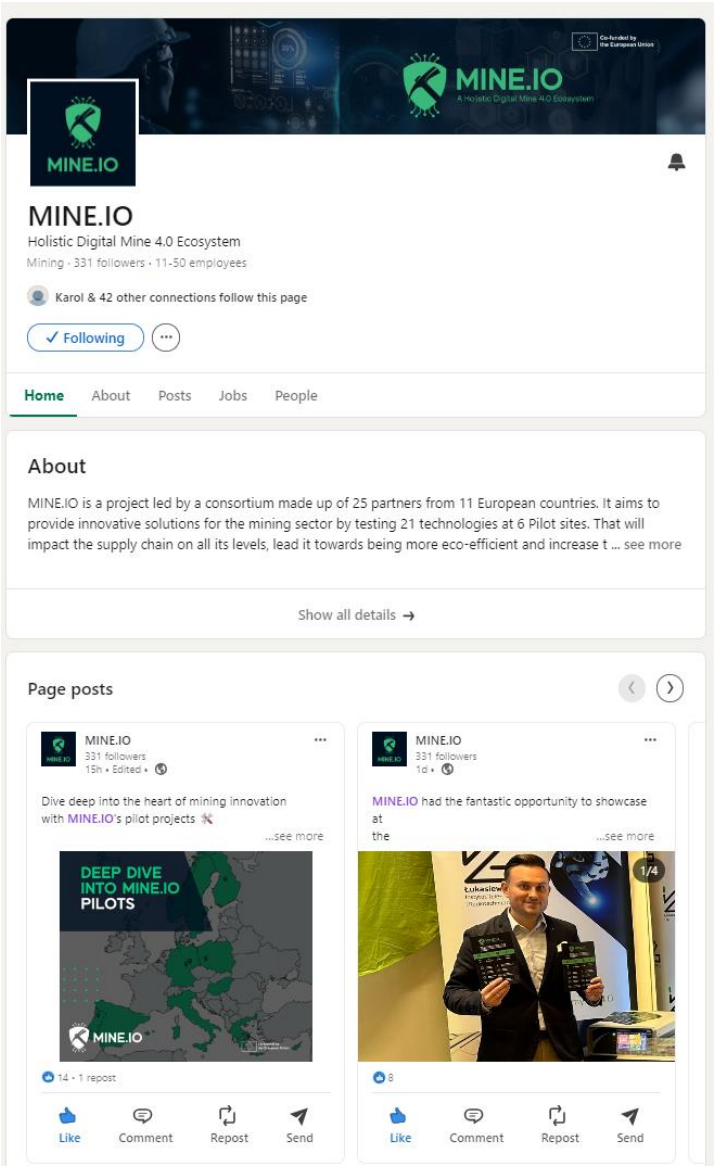

Figure 3 MINE:IO LinkedIn page

2.1.4. YouTube

In 2024, Mine.io launched its official YouTube channel, marking a new chapter in our digital presence. This year, we have begun uploading a variety of content, including summaries of key presentations from the 2023 workshop, which provide concise insights into the event's highlights. Additionally, we have started sharing animations that explain various value chains, offering a visual and engaging way to understand complex processes. We are also in the final stages of preparing a video that will showcase the spring 2024 drone flight tests conducted at the Lavrion mine in Greece. This content will serve to enhance our communication and outreach efforts, providing stakeholders with valuable resources and updates on our latest

activities. We have successfully reached the required video views for this year, which was set at 500 – the channel currently has 608 views.

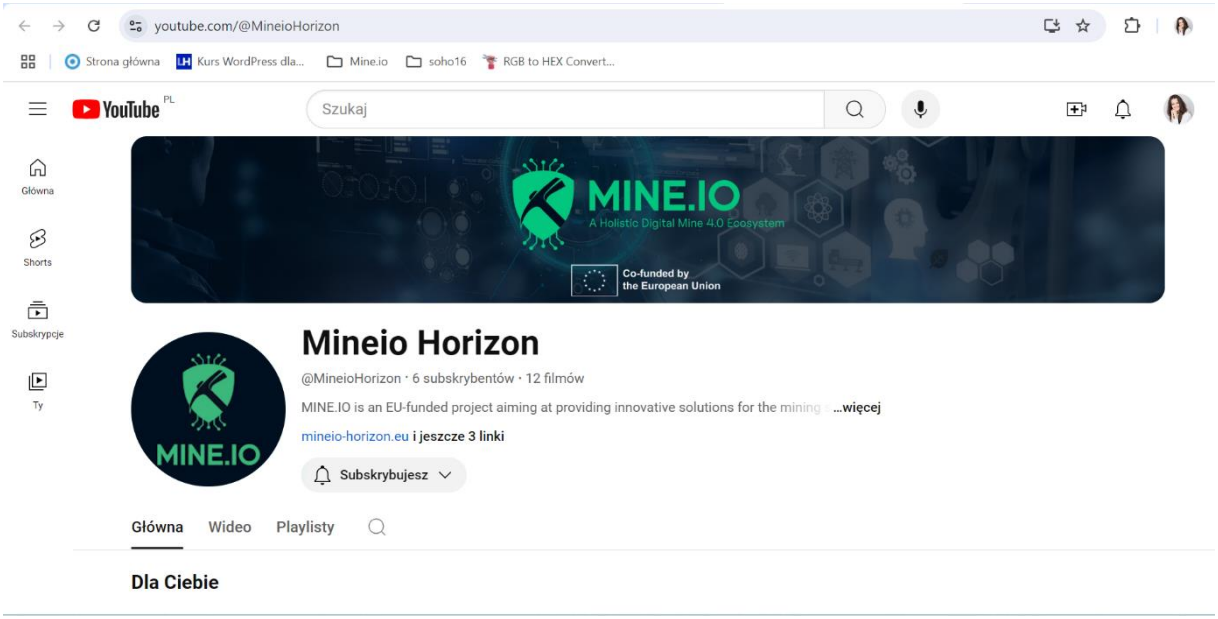

Figure 4 MINE.IO YouTube page

2.2. NEWSLETTER

Mine.io maintains a regular newsletter to keep our subscribers informed about project developments and industry insights. This cyclical communication tool has proven invaluable in summarizing key activities and achievements, ensuring our audience remains engaged and up-to-date.

The first edition of the Mine.io newsletter was released in December 2023, providing a comprehensive overview of the project's progress during its inaugural year. The second edition followed in June 2024, summarizing the activities and milestones of the first half of 2024. These newsletters have been well-received, offering valuable insights and updates to our subscribers.

Looking ahead, we plan to release the third edition in December 2024, which will provide a detailed summary of the events and accomplishments of the second half of the year. Our newsletters are designed to deliver concise, relevant information, fostering a deeper connection with our audience and enhancing the visibility of the Mine.io project.

Previous editions of the newsletter can be viewed here:

December 2023: https://mineio-horizon.eu/wp-content/uploads/2024/07/Mine.io-e-Newsletter-December-2023.pdf

E-newsletter No. 1, December 2023

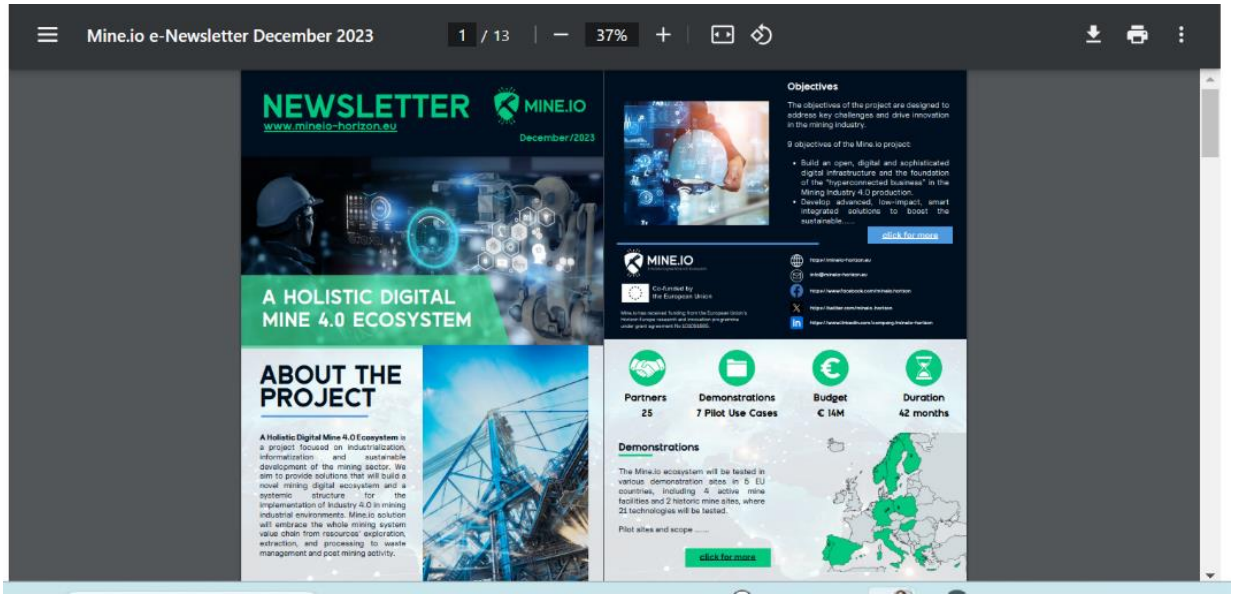

Figure 5 E-newsletter No. 1, December 2023

June 2024: https://mineio-horizon.eu/wp-content/uploads/2024/07/Mine.io-e-Newsletter-June-2024.pdf

Figure 6 E-newsletter No. 1, June 2024

2.3. WEBSITE

The Mine.io website (https://mineio-horizon.eu/) is continually being enriched to provide stakeholders with up-to-date information about the project's activities and to offer access to all publicly available materials.

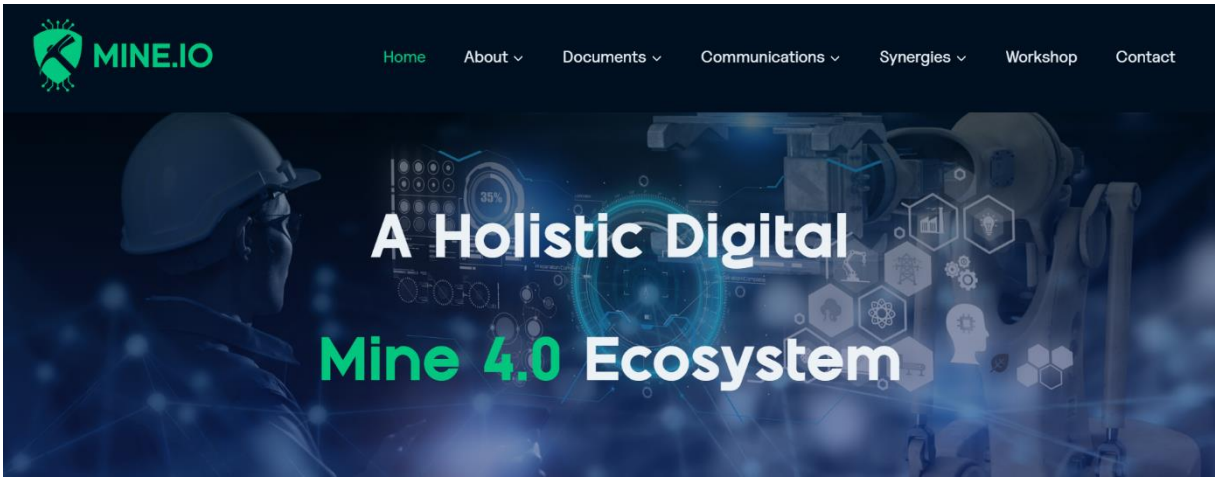

Figure 7 Homepage of the Mine.io project: https://mineio-horizon.eu/

In addition to what was previously reported:

- **About the Project**: This section (https://mineio-horizon.eu/project/) provides a comprehensive overview of the project, detailing its mission, concept, and methodology. This enhanced introduction aims to give visitors a clear understanding of Mine.io's objectives and approach.
- **About the Partners**: This page (https://mineio-horizon.eu/partners/) lists all consortium members, providing details about each partner involved in the Mine.io project.
- **About the Pilot**: This section (https://mineio-horizon.eu/pilots/)presents all the pilot sites of the project across Europe, showcasing the various locations where Mine.io solutions are being tested and validated.
- **Documents**: In this section, visitors can access project deliverables (https://mineio-horizon.eu/deliverables/), publications (https://mineio-horizon.eu/publications/) and promotional materials (https://mineio-horizon.eu/communication-pack/).

We have prepared in this regard:

- 2 updates of the brochure:
  - 2024: https://mineio-horizon.eu/wp-content/uploads/2024/02/leaflet_mineio2024_print.pdf
  - 2023: https://mineio-horizon.eu/wp-content/uploads/2023/07/ulotka-%E2%80%94-kopia-Leaflet.pdf
- Roll-up: https://mineio-horizon.eu/wp-content/uploads/2024/05/Rollup-banner_2024.pdf
- Presentation template
- General presentation about the project
- Brand book:

https://mineio-horizon.eu/wp-content/uploads/2023/06/Mine.io-Brand-Book-2023_EN.pdf

- Selected fonts for the Mine.io project

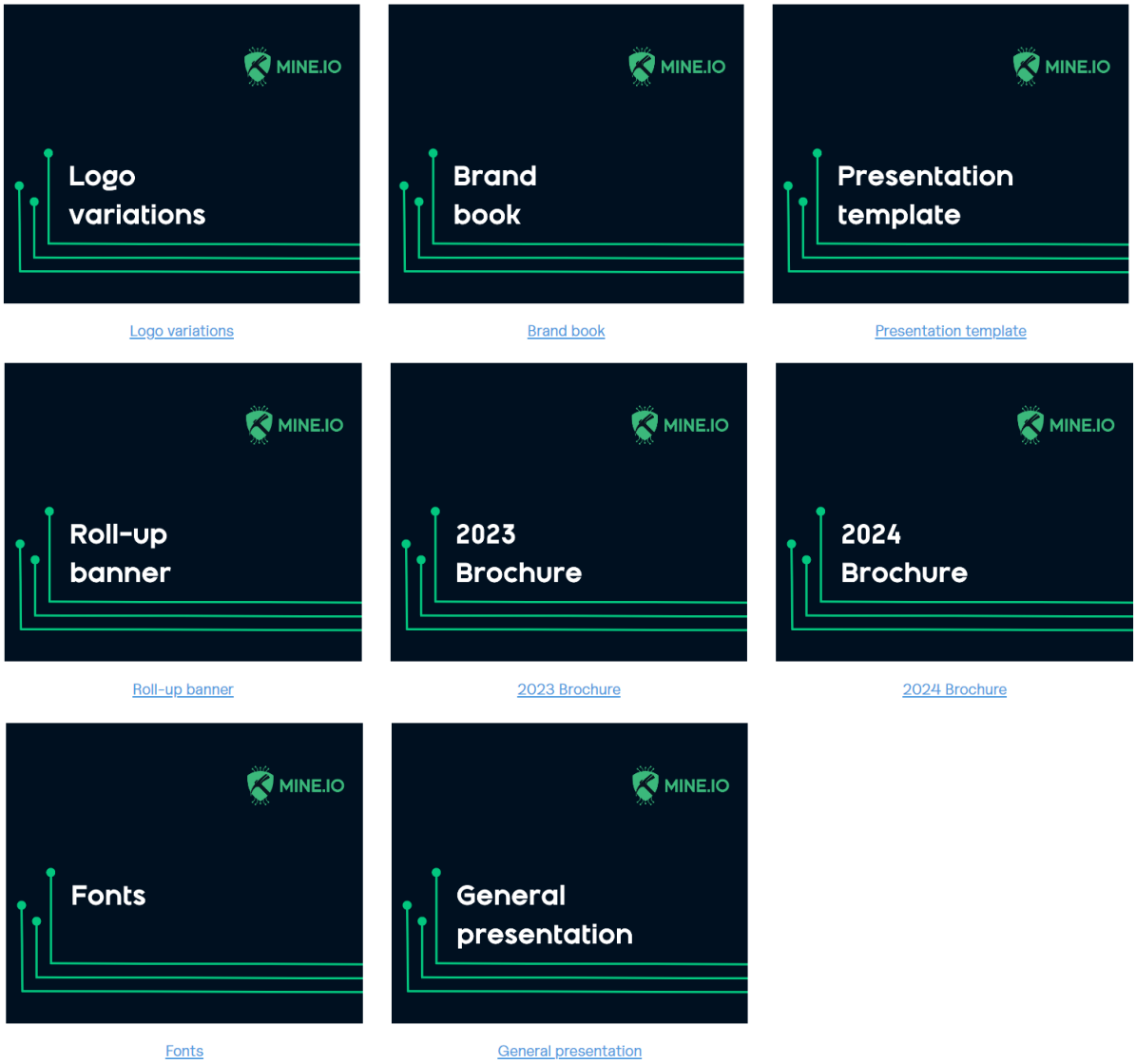

Figure 8 Communication Pack on webpage: https://mineio-horizon.eu/communication-pack/

These documents are available for anyone interested in learning more about Mine.io and its progress.

We also have a dedicated Communications section to highlight our ongoing outreach efforts:

- **News:** This page (https://mineio-horizon.eu/category/news/) is regularly updated with entries about all events in which the Mine.io project participates. It provides a timely and detailed record of the project's involvement in various industry activities.

- **Blog:** This section (https://mineio-horizon.eu/category/blog/) features industry-related articles associated with Mine.io's activities, offering in-depth perspectives and expert insights from our partners.

- **e-Newsletter:** This page (https://mineio-horizon.eu/e-newsletter/) includes all editions of our newsletter, ensuring easy access for subscribers and new visitors alike to stay informed about the latest updates and developments.

These enhancements are designed to improve user experience, increase engagement, and ensure that all stakeholders have easy access to the latest information and resources related to the Mine.io project.

- **Newsletter Subscription**: The website now encourages visitors to subscribe to the Mine.io newsletter via a pop-up window, requiring only their email address. Alternatively, visitors can subscribe through a dedicated banner at the bottom of the home page.

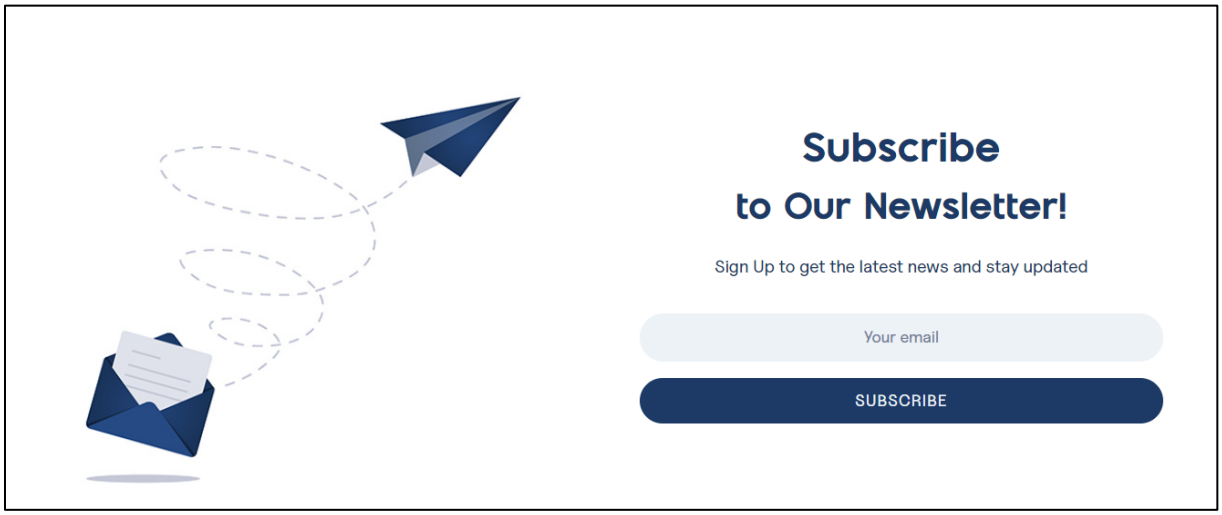

Figure 9 Newsletter subscription banner

These enhancements are designed to improve user experience, increase engagement, and ensure that all stakeholders have easy access to the latest information and resources related to the Mine.io project.

Website Analytics

Based on the analytics from the website https://mineio-horizon.eu/, we observe an upward trend in the number of visits. The primary objectives of tracking website traffic are to assess the effectiveness of our communication efforts and to identify the content that most engages our audience.

The analysis of visits highlights which subpages, news, or articles generate the most interest. These insights enable us to better tailor our communication strategies, enhance the visibility of the most popular content, and refine our dissemination efforts to reach a broader audience. By doing so, we optimize our online presence, supporting the long-term goals of the project related to communication results.

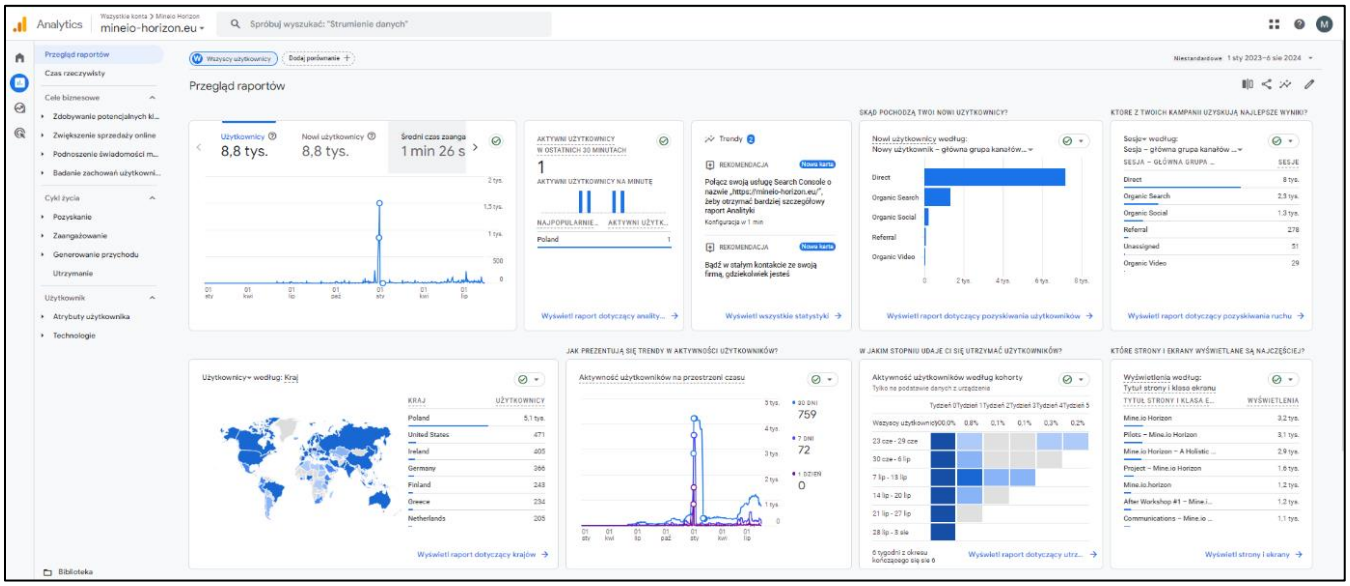

Figure 10 Google Analytics https://mineio-horizon.eu/

There is a clear increase in traffic to our website during periods when we implemented massive information campaigns. For example, the campaign summarising the first Workshop (conducted at the end of 2023 and the beginning of 2024), which, due to the very high intensity of the publication of posts as well as the large amount of substantive content contained therein (reporting on individual areas of the Mine.io Ecosystem value chain), generated significantly more interest than the campaign preparing/announcing the Workshop. We suppose that this was because the campaign prior to the Workshop did not yet contain too much factual information. The conclusions of this analysis allowed us to better prepare the dissemination stratagem and the related campaign to promote the next Workshop in 2024. We have included more substantive content that is also easy to understand for the average audience and we have extended the campaign over time, which has resulted in better results in terms of interest than in 2023 (a clear increase in the months of May-August 2024).

2.4. PUBLICATIONS

In 2023, we were required to meet a publication target of 3, and for 2024, this target has increased to 7. Last year, despite intensive efforts, achieving this target was at significant risk

due to the time-consuming nature of preparing and officially processing such publications, particularly at the early stage of the project.

However, thanks to the dedicated work of the consortium, we were ultimately able to meet the 2023 target. This accomplishment underscores the commitment and efficiency of our team, even in the face of challenging circumstances. As we move forward, the experience gained will help ensure smoother publication processes to meet the more ambitious goals set for 2024.

Published articles

Title of the publication (Publication Link)	Place of publication / Conference / Journal	Download PDF
"3-D muographic inversion in the exploration of cavities and low-density fractured zones"	Published in "Geophysical Journal International" DOI: https://doi.org/10.1093/gji/ggad428	PDF Reprint version from arxiv.org
"Mineral resources depletion, dissipation and accessibility in LCA: a critical analysis"	Published in "The International Journal of Life Cycle Assessment" DOI: https://doi.org/10.1007/s11367-023-02278-3	PDF Author – copy (UNCORRECTED PROOF)
"Innovations in mining sector in the light of recent investigations"	Published in "Kruszywa mineralne, T. 6 / red. nauk. Wojciech Glapa. — Wrocław : Oficyna Wydawnicza Politechniki Wrocławskiej, 2023. — ISBN: 978-83-7493-233-2. — S. 119–128. — Bibliogr." – page 119	PDF (entire journal) PDF (excerpt from the article)
"The state-of-the-art and perspectives of extraction and processing of copper ore in scientific research based on the bibliometric analysis"	Published in "Aktualia i perspektywy gospodarki surowcami mineralnymi : XXXII konferencja : Rytro, 8–10 listopada 2023 : zeszyt streszczeń str.87/ pod red. nauk. Ewy Lewickiej. — Kraków : Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, 2023" – page 87	PDF (entire journal) PDF (excerpt from the article)

Figure 11 Published articles https://mineio-horizon.eu/publications/

2.5. EVENTS

From spring 2023 to spring 2024, Mine.io actively participated in numerous events around the world. Our presence was notable at various **trade shows, conferences, symposiums, webinars, and conventions.** This allowed us to share our expertise, establish valuable connections, and stay up to date with the latest industry trends.

Here is a list of the events and some figures with representative photos depicting Mine.io's participation:

Table 1 List of the Events attended by the Mine.io Consortium

Event Name	**Place & Details**	**Date**
INTARG 2024	Katowice, Poland	4-7.06.2024
Mining Forum 2024	Berlin, Germany	6-7.06.2024
XXXI Geopysiikan Päivät	Oulu, Finland	30-31.5.2024
E-NNOVATE 2024	Kraków, Poland	16-18.05.2024
IPMS 2024, International Post Mining Symposium,	Zonguldak, Turkey	22-24.05.2024
EARTO 2024	Warsaw, Poland	15-16.05.2024
Beyond Expo 2024	Thessaloniki, Grecce in partnership with the NetHelix project	24-27.04.2024
Hannover Messe 2024	Germany with Jotne	22-24.04.2024
AUTOMATION and ROBOTICS EXPO 2024	Athens, Greece	12-14.04.2024
Webinar on Mineral Resources 2024	Online	
PDAC 2024	Toronto, Canada	3-6.03.2024
PDAC 2023	Toronto Canada	5-8.03.2023
SEMAG Symposium 2024	Szklarska Poręba, Poland	22-24.05.2024
ITM 2024	Poznan, Poland	04-07.06.2024
Jotne VCOLLAB Webinar 2024	Online	24.04.2024
The Sensor Decade 2024	Oslo, Norway	05-06.06.2024
ESOF 2024	Katowice, Poland	29-31.05.2024
EEITE'2024 Conference	Greece	29-31.05.2024
Geophysics Negotiation Days	Oulu, Finland	22.11.2023
ENERGETAB 2023	Bielsko-Biala, Poland	12-14.09.2023
VI Mineral Engineering Conference MEC 2023	Wisla, Poland	14-16.06.2023
MINEX Mining 2023	Natural Resources and Technologies Fair, Turkey	13-16.09 2023
International Workshop on Muography 2023	Naples	19-22.06.2023
Warsaw Industry Week 2023	Warsaw, Poland	24-26.10 2023
Diving Talks Workshop 2023	Lisbon Portugal	6-8.10.2023

Figure 12 Jotne Connect at the 'Energizing a Sustainable Industry' event at Hannover Messe.

Figure 13 ACCELIGENCE representation at AUTOMATION and ROBOTICS EXPO 2024 in Athens, Greece

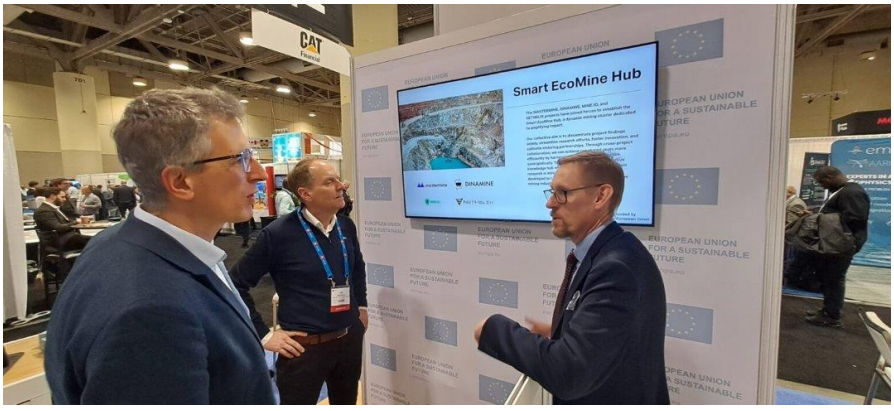

Figure 14 MINE.IO Communications Manager Marek Koscielski and MINE.IO Technical Coordinator Pär-Erik Martinsson at PDAC 2024 in Toronto, Canada

Figure 15 Max Mirko Friedemann at MiningForum 2024 in Berlin, Germany

Figure 16 Łukasiewicz-ITR representative at EARTO conference in Warsaw, Poland

One of the key aspects of participating in events is collaboration with other projects within the established Smart EcoMine Hub (https://mineio-horizon.eu/smart-ecomine-hub/). Projects such as MASTERMINE, DINAMINE, MINE.IO, and NETHELIX have joined forces to create this dynamic mining cluster, aimed at enhancing the impact and efficiency of industry activities. They establish connections, share knowledge, and mutually increase their potential. Through collaboration, they can more easily reach the public and end customers, strengthening their market position.

2.6. AWARENESS CAMPAIGNS

The outreach strategy includes a detailed campaign plan focusing on the importance of Mine.io, the benefits of Industry 4.0 technologies, and the promotion of collaboration in the

mining industry. The campaigns will use LinkedIn and Twitter for promotion, as well as a web page dedicated to the workshop and various outreach tools such as presentations and surveys. By the time of this document's publication, three campaigns have been conducted. The first promoted the workshop, and the second summarized the workshop in 2023. Additionally, the first campaign promoting Workshop No. 2, scheduled before the 2024 workshop, has been launched. Further campaigns are planned for this year.

Based on the experiences of the first workshops, their preparation and activities after the workshop, we will continue as described. We will base our approach on the strategy prepared by the GFT team, allowing us to add and modify as needed and in order to improve the final results.

In addition, we have published a summary of the workshop along with videos summarizing the sessions: https://mineio-horizon.eu/workshop/

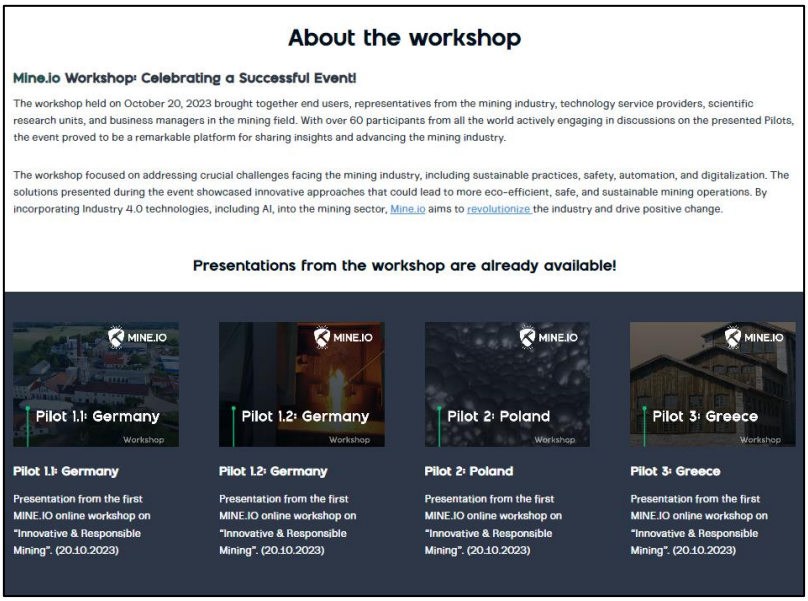

Figure 17 A landing page of https://mineio-horizon.eu/workshop/ with a summary of the 2023 workshop.

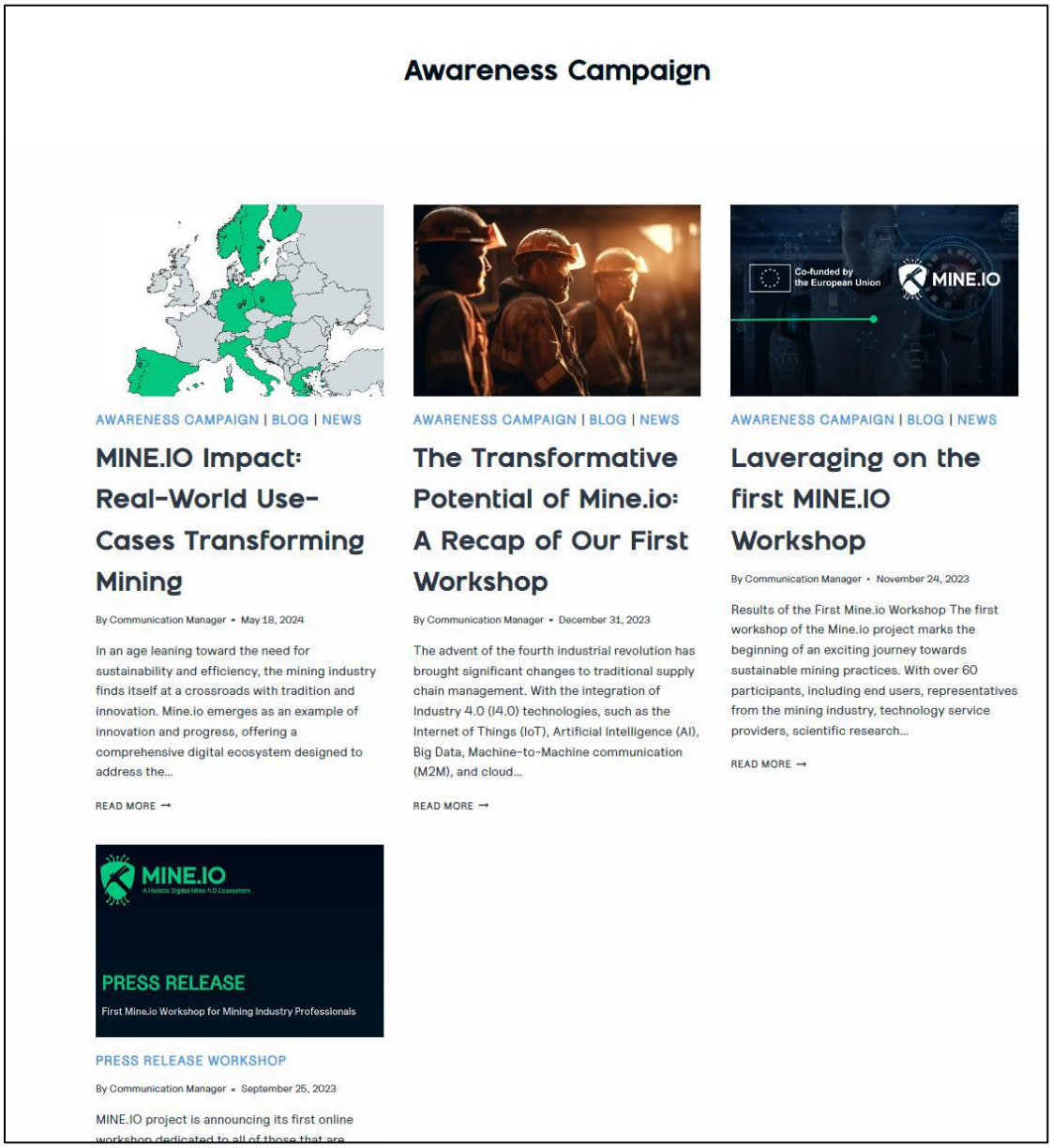

Figure 18 Awareness Campaigns Page https://mineio-horizon.eu/category/awareness-campaign/

2.7. MEDIA

Since the beginning of the year, our media engagement efforts have resulted in a number of online publications in highlighted in national media during the first year of the Mine.io project. These articles, highlighted on our website, focused on the presentation by the Polish project team from Łukasiewicz-ITR, titled "Mines Becoming Smarter: An International Project Involving Poles Aims to Digitalize the Entire Mining Sector." All of these publications were released between December 2023 and January 2024. For a comprehensive list of media mentions, please visit our website: https://mineio-horizon.eu/communications/press-release/.

Figure 19 A subpage of https://mineio-horizon.eu/communications/press-release/

A similar initiative is planned for this year in another country. We are currently starting intensive planning work for this project. We look forward to expanding our media presence and sharing the progress of the Mine.io project with a broader audience.

3 STANDARDISATION

This section outlined the standardisation activities from identifying standards to its contribution and efforts to implement it. At the start of the project, standardisation survey has been conducted to collect various standards that are followed by Partners. And results of this survey are used here to find out the relevant standards in context to Mine.io project specifically benefiting Mining industries. The details about standards survey and its result listed in Annex 6.1.

3.1 STANDARDS OVERVIEW AND HOW TO FIND RELEVANT STANDARDS

Standards Developing Organizations (SDOs) are independent bodies that focus on creating and maintaining technical standards to meet industry needs. These organizations collaborate with experts worldwide to develop appropriate standards based on market requirements. SDOs play a crucial role in coordinating and managing the complex set of standards, technologies, and processes involved in successful project or product implementation. ISO and IEC, in particular, recognize the need for standardized frameworks to facilitate the application of standards and better coordinate the work of their standards committees, see chapter 3.2.

Standardized frameworks play a crucial role in effectively managing industrial standards. Numerous organizations invest significant resources in analyzing industry standards, resulting in standardized frameworks and comprehensive lists of relevant standards. These frameworks facilitate the coordination and management of the large and complex set of standards, technologies, and processes required for successful project or product implementation. ISO and IEC recognize the necessity of standards frameworks, which assist not only those applying standards but also enhance coordination among their numerous standards committees.

In this project, we have distributed standards survey to get the insights of the various standards used by the technologies or organizations in context with Mining domain. We are also under discussion with cluster projects under Mine.io called ‘Smart EcoMine hub’ [10] to understand which standards they are following up and plan to collaborate in sync with this project.

3.2 STANDARDS DEVELOPING ORGANIZATIONS

The identified standards mentioned in the section 3.3 mostly falls under below Standard developing organizations who are responsible for monitoring its development and implementation.

International Organization for Standardization (ISO) is an independent, non-governmental international organization with 165 national standards bodies. It unites experts to share knowledge and develop voluntary, consensus-based, market relevant standards to support innovation and provide solutions to global challenges, like using digital twins to ensure smart production and system operation in smart industry context. ISO is developing standards in all

domains that IEC does not cover. ISO and IEC harmonize their activities closely, especially in smart manufacturing and digital twins. Society of Automotive Engineers (SAE) for Wireless technology and European regulations for drones falls under these standardisation bodies.

3.3 IDENTIFIED STANDARDS

The following standards has been identified based on the Survey and will be following up by the partners throughout this project:

1. ISO 10303 AP242, AP239: EDMtruePLM
2. ISO/IEC 19510:2013
3. PREDICTIVE MAINTENANCE MODULE: MIMOSA OSA-CBM
4. IEEE 802.11 Standard: MQTT Protocols
5. European Regulations concerning to Unmanned Aircraft Vehicles (UAVs) / Unmanned Aircraft Systems (UAS)
6. SAE Standards

3.3.1 ISO 10303: based EDMtruePLM repository

The widespread adoption of digital engineering, production, and operational support tools in various industries has led to a significant challenge for data interoperability. Product-related data, which describe complex systems and their interactions with processes throughout their lifecycle, reside in different software applications with proprietary formats. This data needs to be communicated among applications and, ideally, integrated into a common format for various purposes.

In the context of digital engineering, achieving data interoperability is crucial. By using tool-agnostic approaches and standardized information exchange, we can address the complexities posed by diverse software applications and proprietary formats. Industry consortia must align their data models and terminology to create a common framework for realizing the full potential of IoT and digital twins.

ISO/TC 184/SC 4 [6] is the sub-committee in ISO with the name “Industrial Data”. Taken alone this name, SC 4 is the place to resolve the above issue; this is confirmed by its scope:

“Standardization of the content, meaning, structure, representation and quality management of the information required to define an engineered product and its characteristics at any required level of detail at any part of its life-cycle from conception through disposal, together with the interfaces required to deliver and collect the information necessary to support any business or technical process or service related to that engineered product during its life-cycle”.

ISO published in September 2021, when SC 4 won an award for innovative standardization and good leadership, an informative video of SC 4: https://www.iso.org/news/ref2721.html.

SC 4 has published hundreds of standards since the committee was established in 1984. The standard, or better: the series of standards, that enables the representation of product data

in the most comprehensive way and that also provides the specifications for exchange and storage of such data is ISO 10303. Its title is “Industrial automation systems and integration — Product data representation and exchange”. ISO 10303 is also known as STEP, “Standard for the Exchange of Product Model Data”. ISO 10303 is widely used by industry to exchange CAD-data (Computer Aided Design). Shape representation, however, is only a small part of the ISO 10303 scope. The core of ISO 10303 is a single, consistent, and machine-interpretable data model. Users of the standard can populate this model with all kinds of data and levels of detail for their products in focus; these data become part of the digital representation of these products during their lifetimes. SC 4 has applied this data model to industrial use cases; the resulting specifications are published as “Application Protocols (AP)”. The most prominent APs are the following ones:

- AP209: ISO 10303-209:2014 Multidisciplinary analysis and design
- AP210: ISO 10303-210:2021 Electronic assembly, interconnect and packaging design
- AP232: ISO 10303-232:2002 Technical data packaging core information and exchange
- AP235: ISO 10303-235:2019 Engineering properties and materials information
- AP238: ISO 10303-238:2020 Model based integrated manufacturing
- AP239: ISO 10303-239:2012 Product life cycle support (PLCS)
- AP242 [1]: ISO 10303-242:2020 Managed model-based 3D engineering

Mine.io applies AP242 for the exchange of CAD-data among various technical components; AP239 is used for storing lifecycle data, among those also sensor measurements, in the EDMtruePLM (T5.7) repository which is developed based on this. The advent of the Digital Twin concept has increased the interest in and the importance of ISO 10303. It is the only standard that offers a consistent low level data model with sufficient semantics for Digital Twins. In Mine.io ISO 10303 will be applied beyond the CAD-domain to validate its role in collecting and giving access to personalized and circular manufacturing related data. Among the aspects of attention is the long-term readability of data in this standard format.

Jotne has been active in this sub-committee for more than 30 years. They will be continuing their contributions in relation to the Mine.io project.

3.3.2 ISO/IEC 19510:2013: Business Process Model and Notation Version 2.0 [BPMN v2.0]

ISO/IEC 19510:2013 is an international standard that specifies the Business Process Model and Notation (BPMN) 2.0. BPMN is a graphical representation for specifying business processes in a workflow. Developed by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), ISO/IEC 19510:2013 is aimed at providing a standardized method for modeling business processes that can be readily understood by all stakeholders, including business analysts, technical developers, and business managers. The standard ensures that there is a common language for process modeling, which helps in bridging the gap between the technical and business sides of an organization.

One of the key features of ISO/IEC 19510:2013 is its rich set of graphical elements that enable users to create detailed and comprehensive business process models. The standard provides a collection of symbols such as events, activities, gateways, and data objects, each representing different aspects of a process. Events are triggers that start, change, or end a process; activities represent work that needs to be done; gateways are decision points that affect the flow; and data objects are the information needed or produced in a process. These elements allow for complex modeling of real-world business scenarios and facilitate better communication and understanding of business processes across various departments. However, the standard is not limited to specifying the graphical notation; it also provides a detailed metamodel that defines the structure and semantics of BPMN diagrams. This includes defining the behaviors and attributes of various elements and their relationships within a process. Additionally, ISO/IEC 19510:2013 covers the XML schema for BPMN 2.0, which allows for the exchange of BPMN diagrams between different tools and platforms. This schema ensures that the diagrams are not just visual representations but are also machine-readable and can be processed by various BPM software applications.

BPMN v2.0 in the context of MINE.IO:

The project partner FRON, in the context of T5.1, is leading the development of a solution, titled Workflow Automation Engine, that 1) models and visualises business operation workflows, 2) enables the decentralised collection of permits and certifications that cannot be falsified, 3) allows the digital signing of multi-party business contracts and 4) automates placement of work-orders to external vendors. This multipurpose blockchain-enhanced component is accessible to decision makers via a web-based dashboard application. By using BPMN 2.0, the solution allows decision-makers to design detailed process diagrams that capture the sequence of activities, decision points, and flow of information across the entirety of mining industry workflows.

1. Modeling and Visualizing Workflows: BPMN 2.0 offers a comprehensive set of graphical elements that can be used to model and visualize a wide range of workflows across the mining industry, from operational processes like ore extraction, transportation, and processing, to administrative tasks such as procurement, inventory management, and compliance checks. These BPMN diagrams provide a standardized way to represent complex sequences of activities, decision points, and data flows in a manner that is easily understood by stakeholders across different departments. Within the web-based dashboard application, decision-makers can interact with these models to gain a clear, real-time overview of ongoing operations, identify inefficiencies, optimize resource allocation, and ensure that workflows are aligned with strategic objectives. The use of BPMN 2.0 helps in creating a shared understanding of business processes, fostering collaboration, and supporting continuous improvement in mining operations.
2. Integration with Blockchain for Decentralized Data Collection: BPMN 2.0 models can be integrated with blockchain technology to manage decentralized data

collection processes. In this solution, each step in the process of acquiring permits and certifications is modeled using BPMN 2.0 notations. The blockchain acts as a secure, decentralized ledger to store these permits and certifications, ensuring they are immutable and cannot be falsified. This integration ensures that decision-makers have a clear, real-time view of the status and authenticity of permits, accessible directly from the dashboard.

3. Digital Signing of Multi-Party Business Contracts: BPMN 2.0 is also leveraged to model the complex multi-party processes involved in the digital signing of contracts. By defining the steps for contract creation, negotiation, approval, and signing, BPMN 2.0 diagrams provide a structured and auditable approach to contract management. The blockchain technology embedded within this process ensures that all parties have a secure, verifiable, and time-stamped record of the agreement. BPMN 2.0 helps to visualize and automate these steps, reducing manual errors and speeding up the contract lifecycle.
4. Automated Placement of Work Orders to External Vendors: The BPMN 2.0 notation allows for the automation of work order placements by modeling the interactions between internal processes and external vendors. Using BPMN 2.0, workflows can be designed to trigger automated smart contracts on the blockchain, which then initiate work orders based on predefined conditions and criteria. This automation minimizes delays, ensures compliance with contractual terms, and improves coordination with vendors. The web-based dashboard provides decision-makers with the capability to monitor these automated transactions, manage exceptions, and make informed decisions based on real-time data.

To conclude, BPMN 2.0 is a critical component in this blockchain-enhanced solution, providing a visual, standardized, and automated way to manage and optimize business workflows, ensuring transparency, security, and efficiency.

3.3.3 PREDICTIVE MAINTENANCE MODULE: MIMOSA OSA-CBM

3.3.3.1 PREDICTIVE MAINTENANCE MODULE

The Predictive Maintenance module covers the whole analytics lifecycle, i.e. descriptive, predictive, and prescriptive analytics, by incorporating Machine Learning pipelines and algorithms. In this way, it is able to detect anomalies, predict the future health state, and support decision making about maintenance plans. The Predictive Maintenance functionalities are implemented into an 'Analytics As A Service (Aaas)' platform, being developed by ICCS in the context of T5.2 "Predictive maintenance, net zero carbon and continues development". The Predictive Maintenance module design and development uses the MIMOSA OSA-CBM (Open System Architecture for Condition-Based Maintenance) standard architecture.

3.3.3.2 MIMOSA OSA-CBM

OSA-CBM was developed in 2001 by an industry led team partially funded by the Navy through a Dual Use Science and Technology (DUST) program. The OSA-CBM specification is a standard

architecture for moving information in a condition-based maintenance system. It is capable of contributing to cost reduction, interoperability improvement, incorporating design changes, and further cooperation in the context of predictive maintenance [9]. The development of predictive maintenance systems requires the integration and orchestration of several software and hardware components. OSA-CBM simplifies this process by specifying a standard architecture and framework. It consists of 6 functional blocks (Figure 20) along with the interfaces among these blocks. The standard provides a means to integrate many disparate components and eases the process by specifying the inputs and outputs among the components.

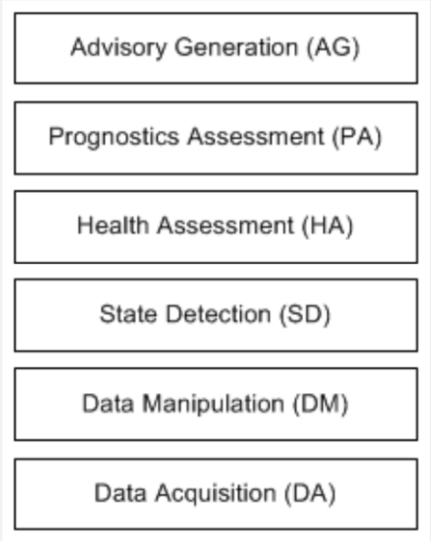

Figure 20 MIMOSA OSA-CBM functional blocks

The OSA-CBM is defined using the Unified Modeling Language (UML) and is designed as a "multi-technological implementation". Vendors and integrators can implement the standard using the appropriate technology for their environment. It is an implementation of the ISO-13374 "Condition Monitoring and Diagnostics of Machines" functional specification, while it adds data structures and defines interface methods for the 6 functionality blocks defined by the ISO standard.

3.3.3.3 Relation of MIMOSA OSA-CBM to the Predictive Maintenance Module

The Predictive Maintenance module's conceptual and technical architecture, as they were described in D5.1 "Mine.io Integration Processing", embeds descriptive, predictive, and prescriptive analytics functionalities, by taking advantage of ML algorithms, in order to detect degradation behaviours, predict the future health state, and support decision making about maintenance plans. In addition, it includes appropriate data storage techniques to handle heterogeneous data sources, and data preprocessing methods for feature engineering and degradation modelling. In this sense, the Analytics As a Service platform being in charge of the aforementioned functionalities adopts the MIMOSA OSA-CBM functional blocks and their interfaces as presented in Table 2.

Table 2 Mapping the MIMOSA OSA-CBM functional blocks to the Predictive Maintenance module's functionalities

MIMOSA OSA-CBM functional blocks	Predictive Maintenance module's functionalities
Data Acquisition (DA)	*Data Storage and Preprocessing*, for feature engineering and degradation modelling
Data Manipulation (DM)	
State Detection (SD)	*Descriptive Analytics*, for diagnosing the current health state and detecting degradation behaviours
Health Assessment (HA)	
Prognostics Assessment (PA)	*Predictive Analytics*, for predicting the future health state
Advisory Generation (AG)	*Prescriptive Analytics*, for supporting decision making about maintenance plans

3.3.3.4 Relation of MIMOSA OSA-CBM to the Workflow Automation Engine

The project partner FRON, in the context of T5.1, is leading the development of a solution, titled Workflow Automation Engine, that integrates the MIMOSA OSA-CBM (Open System Architecture for Condition-Based Maintenance) standard to receive and process messages from the Predictive Maintenance module. By incorporating this standard, the solution ensures seamless integration between the Predictive Maintenance module and other workflows within the mining operations. The messages received from the Predictive Maintenance module, which could include equipment health data, failure predictions, and maintenance recommendations, are fed directly into the BPMN 2.0-modeled workflows. This integration enables decision-makers to visualize the impact of equipment status on business processes and make data-driven decisions to optimize maintenance schedules, reduce downtime, and extend the lifespan of critical assets. Furthermore, using MIMOSA OSA-CBM alongside BPMN 2.0 enhances the automation and efficiency of workflows involving maintenance activities. For instance, when the Predictive Maintenance module sends a message indicating that a piece of equipment requires immediate attention, the workflow can automatically trigger a series of actions, such as issuing work orders to maintenance teams, scheduling replacement parts, or notifying relevant stakeholders. These actions are modeled and visualized through BPMN 2.0 diagrams within the web-based dashboard, allowing decision-makers to monitor and manage maintenance activities in real-time.

3.3.4 IEEE 802.11 Standard: MQTT Protocols

3.3.4.1 IEEE 802.11 Standard

The IEEE 802.11 Standard (Wi-Fi) is a set of protocols for implementing wireless local area network (WLAN) communication. It defines the specifications for wireless networking, including the use of radio frequencies, and data transmission methods. The standard allows devices to connect to networks and communicate wirelessly, facilitating seamless data exchange and connectivity without the need for physical cables.

Wi-Fi will be utilized for the wireless connection between the IIoT gateway and the components of the Pilot Site. This ensures essential connectivity, enabling seamless data exchange between the gateway and various site components.

3.3.4.2 Message Queuing Telemetry Transport Protocol (MQTT)

MQTT is a lightweight messaging protocol designed for sensors. MQTT is widely used in Internet of Things (IoT) applications due to its simplicity and efficiency. This protocol is used for the wireless connectivity and communication of the system with external components, particularly in resource-constrained and unstable network environments.

The MQTT protocol will be used to transport IoT data from the Pilot Site's components to and from the IIoT gateway, ensuring efficient and reliable data transmission.

Support additional IoT standards and protocols for wireless connectivity and communication, if needed based on the Pilot Site requirements

3.3.5 European Regulations concerning to Unmanned Aircraft Vehicles (UAVs) / Unmanned Aircraft Systems (UAS)

3.3.5.1 EU regulations

Due to the increased interest in the use of drones for different applications, both professionally and non-professionally, the EU Commission has adopted a set of rules to achieve a high level of safety and security for drone flights and operations. The EU rules are laid down in Commission Delegated Regulation (EU) 2019/945[2] and Commission Implementing Regulation (EU) 2019/947 [3], which entered into force on the 1st of July 2019. Regulation 2019/947, which focuses on the operation of UAS, applied from the 1st of July 2020.

With these standards the Commission has adopted a risk-based approach, balancing the obligations of drone manufacturers and operators in the areas of safety, security, privacy, the environment, and noise. The aim is to foster innovation and growth in the drone sector. The new legislation includes both technical and operational requirements, replacing existing national rules in Member States.

They range from flight requirements to authorization requirements, and even minimum requirements for remote pilot training. Obtaining an authorization in one Member State allows the operator to freely use their drone in another Member State, facilitating drone operations across the EU. The rules generally apply to drones of every weight class, although lower weight classes (< 25 kg) only need to comply with a minimum set of requirements (e.g., for registration, electronic identification, etc.).

There are three (3) UAS categories in accordance with the Regulations:

a. Open Category: The Open Category is a category of UAS operation that, considering the risks involved, does not require prior authorization by the competent authority nor a declaration by the UAS operator before the operation takes place.
b. Specific Category: The Specific Category is a category of UAS operation that, considering the risks involved, requires a prior authorization by the competent authority before the operation takes place, taking into account the mitigation measures identified in an operational risk assessment, except for certain standard scenarios where a declaration by

the operator is sufficient or when the operator holds a light UAS operator certificate (LUC) with the appropriate privileges.

c. Certified Category: The Certified Category is a category of UAS operation that, considering the risks involved, requires the certification of the UAS, a licensed remote pilot and an operator approved by the competent authority, in order to ensure an appropriate level of safety.

The structure of ACCELIGENCE's UAVs are designed and developed to conform to the stringent standards in the Open Category A1/A3.

3.3.5.2 Standards of the European Union Aviation Safety Agency (EASA) regulations in the Open Category A1/A3 for the drone classification [4]

The European Aviation Safety Agency is the centrepiece of the European Union's strategy for aviation safety. Its mission is to promote the highest common standards of safety and environmental protection in civil aviation. The Agency develops common safety and environmental rules at the European level. It monitors the implementation of standards through inspections in the Member States and provides the necessary technical expertise, training and research. The Agency works hand in hand with the national authorities which continue to carry out many operational tasks, such as certification of individual aircraft or licensing of pilots.

The main tasks of the Agency currently include:

- Rulemaking: drafting aviation safety legislation and providing technical advice to the European Commission and to the Member States;
- Inspections, training and standardisation programmes to ensure uniform implementation of European aviation safety legislation in all Member States;
- Safety and environmental type-certification of aircraft, engines and parts;
- Approval of aircraft design organisations world-wide as and of production and maintenance organisations outside the EU;
- Authorization of third-country (non EU) operators;
- Coordination of the European Community programme SAFA (Safety Assessment of Foreign Aircraft) regarding the safety of foreign aircraft using Community airports;
- Data collection, analysis and research to improve aviation safety

The structure of the ACCELIGENCE's UAVs is designed and developed to conform to the stringent standards of EASA regulations in the Open Category A1/A3 when the payload attached to the UAV is a regular sensor (RGB, Multispectral, Thermal camera).

Within this category, the drone is classified as low-risk for flight operations, underscoring our commitment to ensuring safe and responsible drone usage. The Open Category A1/A3 is a crucial framework defined by EASA to promote the safe integration of drones into the airspace. The UAVs that will be used in this project have been carefully categorized based on their weight and features, allowing us to operate it with a reduced administrative burden while upholding the highest levels of safety and compliance.

3.3.5.3 ISO/TC 20/SC

ISO/TC 20 [7] is a technical committee of the International Organization for Standardization (ISO) responsible for developing internationally accepted standards for aircraft and space vehicles. This covers standards for the materials, components and equipment used to both develop and maintain them, including:

- Design
- Construction
- Test and evaluation
- Operation
- Air traffic management
- Maintenance
- Disposal/end of life
- Safety, reliability and environmental considerations

3.3.5.4 GDPR

Drone surveillance activities will fall within the scope of the GDPR [5] insofar it involves the processing of personal data. There are, however, a few situations in which the GDPR will not apply, namely: 1) "in the course of an activity which falls outside the scope of Union law; 2) by Member States when carrying out activities which fall within the scope of Chapter 2 of Title V of the TEU (common foreign and security policy); 3) by a natural person in the course of a purely personal or household activity (household exemption); 4) by competent authorities for the purposes of the prevention, investigation, detection, or prosecution of criminal offences or the execution of criminal penalties, including the safeguarding against and the prevention of threats to public security.

In general, the processing of personal data through drone surveillance by the State or law enforcement authorities incurs a high risk for the rights and freedoms of data subjects. However, the use of drones by private individuals for personal purposes can also closely resemble surveillance activities.

Surveillance activities by drones will usually involve the processing of personal data (e.g., collection, storage, analytics, etc.), which may include several types of data, such as images, video and audio footage, location data, behavioural data, health data, biometric data, etc. The processing of personal data by drones thus gives rise to risks to the rights and freedoms of data subjects. These risks can be traced back to several general data protection principles, such as a lack of transparency of processing activities and types of personal data, a lack of knowledge about the purposes of processing, unclear processing safeguards, and a lack of a clear legal basis.

3.3.6 SAE Standards

For most of the development that are foreseen in the inductive charging environment, it is relevant to search for all the existing IC standards related to the different main features and operational requirement the wireless charging is intending to fulfil.

Additionally, to cover the technical elements present in this technology concerning the vehicle and its functionalities, it is important to follow what the SAE is constantly doing to set the standards in the automotive industry.

In the domain of the construction, it would recommended also to follow the different set of norms that might be relevant for the materials in force in Europe.

The IC standards refer to the standards and guidelines established for the design, manufacturing, and testing of integrated circuits (ICs). These standards ensure compatibility, reliability, and quality across different devices and manufacturers. Key organizations involved in setting IC standards that ENRX would advice to take into account include:

- IEC (International Electrotechnical Commission): Develops international standards for all electrical, electronic, and related technologies.
- IEEE (Institute of Electrical and Electronics Engineers): Publishes standards for a wide range of technologies, including IC design and testing.
- ISO (International Organization for Standardization): Works on global standards, some of which pertain to semiconductor and IC technologies.

Concerning the SAE, these standards ensure that products meet high standards of quality and performance. By adhering to these guidelines, manufacturers can produce reliable, durable, and effective components and systems, maintaining consumer trust and satisfaction. Safety is a primary goal of SAE standards, which include stringent requirements and testing procedures to protect users and passengers from potential hazards. Compliance with these standards helps prevent accidents and injuries, enhancing public confidence in automotive and aerospace products.

SAE standards facilitate compatibility and interoperability among components and systems from different manufacturers. This is crucial in the automotive and aerospace industries, and particularly important when it comes to the inductive technology, where different parts and systems must work seamlessly together. Standardization ensures that components can be easily integrated and replaced, simplifying maintenance and repairs while promoting efficiency in manufacturing and supply chains.

Compliance with SAE standards helps manufacturers meet regulatory requirements and adhere to industry best practices. This ensures that products are legally compliant and align with international norms and expectations. By following these standards, manufacturers can avoid legal issues and penalties, facilitate market entry, and enhance their reputation as reliable and trustworthy providers of automotive and aerospace products.

In the case of the construction norms, the most important in the frame of work in Europe would be the EN Norms. The EN norms, also known as European Norms, are standardized guidelines and specifications that ensure products, services, and systems within the European Union (EU) meet consistent quality, safety, and performance criteria. These norms are developed and maintained by the European Committee for Standardization (CEN), the

European Committee for Electrotechnical Standardization (CENELEC), and the European Telecommunications Standards Institute (ETSI).

EN norms ensure high quality and performance standards for construction materials, guaranteeing their suitability and durability. They set safety guidelines to protect workers and the public, ensuring materials can withstand specified loads and stresses. These norms also facilitate compatibility between components from different manufacturers, simplifying construction processes. Adhering to EN norms helps companies comply with European regulations, often necessary for project approvals. Many EN norms promote environmental protection by encouraging sustainable practices and the use of eco-friendly materials. Lastly, they support innovation by providing clear guidelines for developing new materials and technologies.

For the technological developments of the wireless dynamic charging and the design and production of the hardware defined for the mine.io electrification initiative, a significant effort has been made to study the relevant guidelines and norms that shall be used.

From the available existing guidelines, more than 20 have been identified as having a potential relevance for the current works. In those Guidelines, according to the scope, more than 15 Chapters have been defined as to “be applied”.

- Concerning the Ground Assembly: From the EN available norms, more than 1100 have been identified as having topics related to the present developments and approximately 400 seem to be relevant and are under direct study for the production of the Ground Assembly.
- Concerning the Vehicle Assembly: From the EN available norms, more than 1800 have been identified as having topics related to the present developments and approximately 250 seem to be relevant and are under direct study for the production of the Vehicle Assembly.
- Concerning the civil construction processes: From the EN available norms, more than 690 have been identified as having topics related to the present developments and approximately 50 are relevant and shall be used for the civil construction of the track infrastructure.

One of the most important results on the standardization survey, is that the particular topic of inductive charging is still under development around the world today.

This situation means that probably the most relevant specific standard for the inclusion of inductive charging equipment in the heavy-duty vehicles is the SAE standard J2954-2 [8].

The J2954/2 Wireless Power Transfer for Heavy-Duty Electric Vehicles is currently under development and ENRX is taking part in the committee in charge of its edition. This Standard belongs to the general SAE J2954 which established an industry-wide specification that defines acceptable criteria for interoperability, electromagnetic compatibility, EMF, minimum performance, safety, and testing for wireless power transfer (WPT) for light duty plug-in

electric vehicles. The SAE J2954/2 is the SAE Information Report defining new power transfer levels in the higher power ranges needed for heavy-duty electric vehicles.

The J2954/2 Wireless Power Transfer for Heavy-Duty Electric Vehicles will start an action for the assessment of the wireless technology running tests at the ASPIRE Utah State Test Track, more specifically at the Electric Vehicle Road Center (EVR) in Logan, Utah USA. Those tests will take place at the EVR using the dynamic wireless technology from different suppliers including the technology from ENRX, as it has been developed to be used in the Pilot 5 in Mine.io.

4 CONCLUSIONS AND NEXT STEPS

The next phase of the project will continue to effectively reach more target audience to successfully disseminate the project outcomes followed by the standards validation results, and contribution related to the standardisation.

The standards in context with the technologies such as blockchain, interoperability will be evaluated during the next phase of this project to identify their influences related to Mining industry and followed by our contribution if any. Some of the potential additional standards to be analysed includes:

- Various Ethereum Improvement Proposals (EIPs)
- Ethereum Request for Comments (ERCs)
- ERC1155 token standard
- ISO/IEC 21778:2017

The summary of compliance and progress in Mine.io Communication and Dissemination activities as follows:

The outline of activities conducted as a part of the Mine.io report indicates that all steps taken are in compliance with the provisions of Agreement D7.2, the Mine.io Communication and Dissemination Strategy and Plan. The executed actions cover a wide range of communication activities, including managing social media presence, updating the website, publishing newsletters, and participating in industry events. Each of these elements is at various stages of completion, but all are being executed according to schedule and are achieving the intended goals. Therefore, all steps have been completed on time and are in line with the agreed-upon objectives, demonstrating the effective implementation of the Mine.io project's communication and promotional strategy.

All of these activities have led to Mine.io becoming visible and interesting to the wider community including other projects addressing challenges in the mining and IT sectors. As a result (during the M1-M21 reporting period) we have been able to:

- Contact with a wide range of projects to share experiences and establish collaborations.
- Participate in the EU Supercluster Lapland geoconference, which brought together more than 65 organisations from 25 projects with a focus on raw materials, from 25 countries. During the event we exchanged knowledge and had many discussions with representatives of projects such as: EIS, AGEMERA, CIRAN, EXCEED, GOLDENEYE, GREENPEG, M4MINING, MaDiTraCe, MinExTarget, MultiMiner, S34I, SEEMS DEEP and SEMACRET. Topics of discussion and exchange of experiences were related to exploration and mining, with a particular focus on increasing Europe's sovereignty in key raw materials and how innovative technologies can be used to achieve this (including digitisation of the mining sector).
- Established contact with three projects funded under the same competition. A series of meetings were held with representatives of these projects responsible for

dissemination, awareness raising and exploitation to establish possible cooperation. The result was the creation of the Smart EcoMine Hub cluster, which seeks synergies in the work of these projects. A cluster brand has been created and each of the partners has carried out awareness campaigns about the creation of the cluster on their own social media. The cluster was also successfully presented at several events attended by representatives of the associated projects. A sub-page on Mine.Io dedicated to information about the cluster has also been created. The link to the sub-page can be found below: https://mineio-horizon.eu/smart-ecomine-hub/

- Achieved KPIs as in the table below:

KPI's description	Expected performance		Achieved performance	
	Year 1	Year 2	Status 2023	Status Q2 2024
Communication Strategy&plan: Annual project review	Positive	Positive (Update)	Positive	in progress
Website - number of visitors (unique, returning)	250/month	400/month	425	350
Social media - total number of followers	250	550	279	>550
Social media - total number of posts	200	200	200	>150
Social Media Campaigns - total number	1	≥2	3	>2
No of project video views - total number	≥0	≥1	1	>3
Video views on YouTube	-	500	614	>600
Communication kit: brochures and posters	≥ 2	≥ 2 (Updated)	4	2
Printed material distributed	300	300	>300	>300
No of e-Newsletter - total number	≥1	≥2	1	1
Quantity of media coverage achieved	≥10	≥10	> 22	>2
No of peer reviewed publications	≥3	≥7	3	
Readership results	150	200	1379 (views)	
No of Mine.Io Workshops	1	≥1	1	
No of End Users attending Mine.Io workshops	40	≥60	83	
No of project events in conferences/congresses	≥1	≥2	10	9
No of presentations	≥10	≥18	13	9
No of demonstrations/exhibitions	-	≥1	1	

No of Awareness campaigns	≥2	≥2	2	1 in progress
No of public & Media attending Final event	-	-		
No of End Users Engaged	≥50	≥100	83	
No of industry representatives involved	≥25	≥40	28	
No of associations & organisations involved	≥3	≥5	5	2
No of projects contacted	≥8	≥8	>8	>5
No of liaison activities performed	≥5	≥10	>5	>10

The future version of this deliverable will cover activities listed below:

1. collaboration with Smart EcoMine Hub, among others, to identify standards and related common practices used by sister projects,
2. also the results of the validation of SAE standards by ENRX related to wireless technology,
3. further awareness campaigns,
4. further dissemination, communication and outreach activities.

5 REFERENCES

1. AP242: http://www.ap242.org/
2. Commission Delegated Regulation (EU) 2019/945: https://eur-lex.europa.eu/eli/reg_del/2019/945/oj
3. Commission Implementing Regulation (EU) 2019/947: https://eur-lex.europa.eu/eli/reg_impl/2019/947/oj
4. EASA regulations in the Open Category A1/A3 for the drone classification: https://www.easa.europa.eu/en/domains/drones-air-mobility/operating-drone/open-category-low-risk-civil-drones
5. GDPR: REGULATION (EU) 2016/ 679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL - of 27 April 2016 - on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/ 46/ EC (General Data Protection Regulation) (europa.eu)
6. ISO/TC 184/SC4: http://committee.iso.org/home/tc184sc4
7. ISO/TC 20: https://www.iso.org/committee/46484.html
8. J2954/2: https://www.sae.org/standards/content/j2954/2_202212/
9. MIMOSA-OSA-CBM: https://www.mimosa.org/mimosa-osa-cbm/
10. SmartEcoMineHub: Smart EcoMine Hub – Mine.io Horizon (mineio-horizon.eu)

6 ANNEX

6.1 STANDARDISATION SURVEY RESULT

The survey results shown below:

Partners	Standards	Type of involvement	Focus of this standard	Mine.io components	Relevance for Mine.io categories			
					Develop sustainable and smart mining technologies for exploitation of EU mineral resources	Contribute to a more safe and environmentally friendly, resource- and production efficient sustainable mining	Develop methods, technologies and processes aiming for digitisation and automation of raw materials production.	Contribute to the implementation of the following actions of the EU Action Plan on Critical Raw Materials: Action 8:Develop Horizon Europe R&I projects on processes for exploitation and processing of critical raw materials to reduce environmental impacts starting in 2021 and Action 3: Launch critical raw materials R&I in 2021 on waste processing, advanced materials and substitution.
PoliTO	ISO/AWI TR 3502	Develop	Robotics and automation	4, 5, 12, 14, 17	Yes	No	Yes	Yes
LTU	ISO-17757	Develop	Robotics and automation	14, 21		Yes	Yes	Yes
Innov-acts	ISO 10303	Use	Interoperability and Big Data	16	Yes	No	No	No
TECNALIA	IEEE 2418.2-2020	Use	Interoperability (sharing of data and resources between different systems)	24	No	No	Yes	Yes
University of Oulu -	Global Industry Standard on	Develop	Mine waste management	18, 24		Yes		Yes
ICCS	ISO 13374 - MIMOSA OSA-CBM	Use	Interoperability (sharing of data and resources between different systems)					
ACCELIGENCE ltd	European Union Aviation Safety Agency (Open Category A1/A3)	Use	Robotics and automation	21	Yes	Yes	Yes	Yes
GFT	BPMN (Business Processing modelling notation)	Use	Orchestration (configuration, coordination, and management of systems)	27	No	No	Yes	Yes
Muon Solutions Oy		Develop	Terminology	1, 2, 3, 5, 25, 26	Yes	Yes	Yes	Yes
Fluorchemie	Advanced automated mining	Develop	Security & safety	4, 9, 11, 12, 14,26	Yes	Yes	Yes	No
Wigner Research Centre for Physics		Monitor/Develop	Interoperability (sharing of data and resources between different systems)	1, 2, 3, 4, 6, 18, 23	Yes	No	No	Yes
Jotne	ISO 10303	Contribute/Monitor	Circular economy, Interoperability (sharing of data and resources between different systems), Orchestration (configuration, coordination, and management of systems), IoT	4, 5, 6, 10, 13, 17, 25, 26	Yes		Yes	Yes
	ISO 23247	Monitor/Use	Terminology, Interoperability (sharing of data and resources between different systems), Portability (enables using the system in different environments)	4, 6, 14, 21, 22	Yes	Yes	Yes	

Partners	*Standards*	*Type of involvement*	*Focus of this standard*	*Mine.io components*	*Relevance for Mine.io categories*			
HMU	LoRaWAN	Use	IoT, Big Data	17	Yes	No	Yes	No
ENRX	ISO 12100	Develop/Use	Security & safety	12, 13, 14	Yes	Yes	Yes	
	ISO 13849	Use	Portability (enables using the syst	12, 13, 14	Yes	Yes	Yes	
	ISO 26262	Use		12, 13, 14	Yes	Yes	Yes	
	ISO 19363	Use	Security & safety	11, 12, 13	Yes	Yes	Yes	
	CISPR 11	Use	Security & safety	11, 12, 13	Yes	Yes	Yes	
	CISPR 16	Use	Security & safety	11, 12, 13	Yes	Yes	Yes	
	ICNIRP 2010	Use	Security & safety	11, 12, 13	Yes	Yes	Yes	
	J2954/2_202212	Contribute/Monitor	Interoperability (sharing of data and resources between different systems)	11, 12, 13	Yes	Yes	Yes	
	IEC 61980	Monitor/Use	Interoperability (sharing of data and resources between different systems)	11, 12, 13	Yes	Yes	Yes	
	ISO 15118	Use	Interoperability (sharing of data and resources between different systems)	11, 12, 13	Yes	Yes	Yes	
	ISO 11898	Use	Interoperability (sharing of data and resources between different systems)	12, 13	Yes	Yes	Yes	
	IEC 60502-1	Use	Security & safety	11, 12	Yes	Yes	Yes	
KGHM Polska Miedź S.A.			Terminology, Quality, Security & safety	16	No	No	No	No
TU Bergakademie Freiberg	ETSI EN 300 220-1 V3.1.1	Use	Portability (enables using the system in different environments), Orchestration (configuration, coordination, and management of systems), Quality, Security & safety, IoT		Yes	No	Yes	No
	ISO/AWI TR 3502	Develop	IoT	6	No	No	Yes	No
Fraunhofer	ISO 13849	Use	Orchestration (configuration, coordination, and management of systems), Quality, Security & safety	7, 8, 15	No	Yes	No	No
	DIN 54113-1	Use	Security & safety	7, 8, 15	No	Yes	No	No
Frontier Innovation Centre	ISO/IEC 19510:2013 (BPMN v2.0)	Use	Business Process Modeling and Automation	27	Yes	No	Yes	No
	ISO 13374 MIMOSA OSA-CBM	Use	Interoperability (sharing of data and resources between different systems)	27	Yes	No	Yes	No

Mine.io Components
1.Underground muography instrumentation
2. Waterproof casing for an underwater muon detection system
3.Underwater muon imaging system
4.Autonomous exploration underwater robot
5.Digital twin underwater data export software system
6.Infrastructure for flooded mine exploration/ digitalization
7.Smart drill core analysis with X-ray diffraction
8.Smart drill core analysis with X-ray computed tomography
9.Development of new concepts for automated big data mining and AI for MWD-data
10.Development of virtual test bed for demonstration of MWD results
11.Primary track pavement
12.Primary electronic sub-system
13.Secondary sub-system (mechanical, electronic and hardware)
14.Autonomous driving
15.Dual energy x-ray sorting using deep learning
16.PIT System and software
17.Sensor based-digital-twins-for-smelting system
18.Surveillance and monitoring of tailings facilities
19.Passive seismic interferometry
20.Characterization system for stockpiles
21.UAV system prototype
22.Digital architecture for the 3d slagheap model (data acquisition module included)
23.Simulation processes algorithms for the 3D dump model evolution
24.Sustainable waste management based on distributed ledger technology
25.Digital Twin Infrastructure including IoT
26.Data Interoperability
27 Business Process Workflows Modelling, Decentralization and Automation module