A Holistic Digital Mine 4.0 Ecosystem

D7.1
Market Shaping, open fair repository, scale-up business models and socio-economic impact – version 1

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Lead Beneficiary	ACC
Status	Final
Version	1.0
Due Date	30/09/2024
Delivery Date	30/09/2024
Dissemination Level	PU - Public

MINE.IO is a project co-funded by the European Commission under the Horizon Europe Programme under Grant Agreement No. **101091885**

Project	MINE.IO – 101091885
Work Package	WP7 – Market shaping, scale-up business models and socioeconomic impact & Mine.io outreach and awareness generation
Deliverable	D7.1 – Market Shaping, open fair repository, scale-up business models and socio-economic impact – version 1
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Abstract	This report presents a preliminary market analysis for the Mine.io results, as well as their competitive market positioning to ensure large-scale deployment and adoption.
Disclaimer	

Executive Summary

This deliverable presents the results of T7.1 "Market Analysis and Strategy Definition" and T7.2 "Socio-economic Sustainability Analysis and Mine.io Ecosystem Business Models and Uptake Roadmap" which are activities lead by ACC and AMDC respectively and run from M10 to M42. This deliverable covers the results of these two tasks up to M21.

The key objective of T7.1 is to perform a thorough market analysis and a regulatory landscape investigation of Mine.io technologies and solutions. This deliverable covers an initial market analysis of Mine.io solutions and the mere intentions of the consortium on exploiting these technologies and solutions after the end of the project. In addition, this deliverable presents the potential business models of Mine.io exploitable technologies and solution, as well as the competitive landscape of relevant technologies to be developed. An initial SWOT analysis was further considered for Mine.io technologies which was provided by the consortium partners.

Subject to the progression and development of the project's key exploitable results, a second and third version of this deliverable, D7.4 (M33) and D7.5 (M42) will be delivered, covering an in-depth market analysis and cost-benefit analysis. Lastly, a business plan will be incorporated in the subsequent deliverables, describing the exploitation activities and business operations for Mine.io.

Task 7.2 focuses on the social, economic and environmental aspects and influence of the proposed Mine.io. solution including local communities and stakeholders engagement for broadening project's social acceptance. It also aims on coordinating the scientific outreach through open access publications and participation in well-known events; The final target is to support a future large-scale deployment, of the Mine.io Ecosystem across Europe. In the context of the current deliverable, the methodology of identifying key socioeconomic and environmental factors, specialized in each of the different Mine.io. Pilots is presented, along with the findings of each individual Pilot Site. The immediate next steps include the publication of a scientific paper and the establishment of measurable values for each indicator through the evolvement of the Pilot Sites.

The development of an open fair repository will be addressed in version 2 of this deliverable.

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Terms and Abbreviations

AI	Artificial Intelligence
AR	Augmented Reality
AVs	Autonomous Vehicles
BMC	Business Model Canvas
DoA	Description of Action
EASA	European Union Aviation Safety Agency
EC	European Commission
EPRM	European Partnership for Responsible Minerals
EPRN	Economic Policy Research Network
EU	European Union
GDPR	General Data Protection Regulation
IMA	Integrated Modular Avionics
IoT	Internet of Things
IPR	Intellectual Property Rights
ISO	International Organization for Standardisation
IT	Information Technology
M	Month
ML	Machine Learning
PLM	Product Lifecycle Management
R&D	Research & Development
SME	Small Medium Entity
SWOT	Strengths, Weaknesses, Opportunities, Threats
VPC	Value Proposition Canvas
WP	Work Package
3D	Three dimensions

1. INTRODUCTION

During Mine.io project different technologies are developed and will be validated at 8 pilot sides across the EU. These technologies cover the entire mining value chain, including exploration, ore extraction and processing, waste management and post-mining activities, with also a focus on electrification solutions for underground mining environments. At each pilot, different technologies and solutions will be tested and validated. These technologies are purposed with the digitilisation of the different stages of the mining value chain, while Mine.io is also purposed with providing the digitilisation infrastructure, the platform ecosystem that will embrace the different Mine.io technologies under a unified framework and architecture.

Details of the Mine.io concept, pilots and the technologies to be tested and validated at each pilot are set out in D5.1 «Mine.io integration processing» and D2.1 «Functional and Non-Functional Requirements in the Digitisation of the Mining Sector – Version 1». A description of each pilot is also provided in D6.1 «Report on Mine.io European pilot campaign plan and evaluation methodology» (section 2).

This deliverable presents an outline of the market analysis of each exploitable asset/result that is developed or derived from Mine.io, the taxonomy of these exploitable assets/results, the IPR management and contributions of the partners and their intentions as to the exploitable pathways and intentions. The market analysis also includes an initial SWOT analysis for the Mine.io technologies, along with potential business models as BMC and VPC. These results are based on the partners contributions provided during the course of T7.1.

More specifically the deliverable focuses on the:

Mine.io exploitation planning: information has been collected and documents with regard to the exploitable assets and results of the project including information about the type of the different assets and initial IPR management and exploitation. This information is analysed in terms of exploitable potential and towards identifying the Key exploitable results.

Further, the deliverable sets out initial business models for the purposes of the assets' exploitation, commercialisation and monetization.

Market analysis activities: An initial market analysis of Mine.io products and services is presented focusing on the current market and on competing and related solutions about mining. For the protection of the partners' IPR, the input of the partners has been analysed and is being summarised in this deliverable.

For the remainder of the project, exploitation work will continue by emphasising on the KER and their further exploitation, by detailing the business models and business plans while at the same time completing the market analysis work.

Socio-economic & Environmental Impact: The main objective of the current effort in the context of Mine.io includes:

- Define the indicators for the socio-economic sustainability of the Mine.io results

- Highlighting the importance of balancing social, economic, and environmental objectives
- Identify differences and similarities between different User Cases and Pilots
- Assessing the impact of the future mine.io adoption and future scaling-up initiatives.

All feedback given by the Pilots will be considered to provide and enhance a future cost-benefit analysis of Mine.io and present a scenario analysis, with the inclusion of forecasts and key impact pathways for the next 5 to 10 years.

The development of an open fair repository will be addressed in version 2 of this deliverable.

1.1 Document structure

Section 1 provides an introduction to this deliverable.

Section 2 provides the Mine.io taxonomy of exploitable assets and IPR Claims.

Section 3 presents an overview of the market analysis, along with the competitive landscape, legal framework and value proposition.

Section 4 will present the methodology of defining Socio-economic, environmental & compliance aspects for Pilots of Mine.io. Project.

1.2 Methodology

For the purposes of carrying out T7.1 and consequently to prepare this deliverable, the task leader ACC, liaised with the partners of Mine.io consortium to obtain their insights and contributions with regards to each partner's exploitable technology and business perspective. The objective was to identify each previously defined asset, which partner is responsible for those assets and collect respective contributions.

This assisted in detailing a list of Mine.io's exploitable assets/technologies, the partner's contributions to these (i.e. if they brought background knowledge that existed before the project and/or if they developed new foreground knowledge while working on asset that can/will be exploited), and their intended exploitation pathways.

For these purposes the following forms/surveys were prepared and shared with the consortium:

a. A list of exploitable assets/technologies, a template of which is presented in **ANNEX 1**, which the partners used to provide information on their contributions and intended exploitation actions.

b. A partners fill-in form, presented in **ANNEX 2**, containing six sections about the market. This form was shared within the consortium and completed separately for each technology.

Since this is a public deliverable and for the purposes of protecting the IPR of the partners, the completed forms are not attached to this deliverable, but a mere analysis of their input is provided.

It is highlighted that this report merely contains a first draft of the market analysis and potential business models of Mine.io. Subject to the progression and development of the key exploitable results of the project, a second and third version of this deliverable, D7.4 (M33) and D7.5 (M42) will be delivered.

1.3 Relation to other WPs/Tasks

Tasks 7.1 «Market analysis and strategy definition» and T7.2 «Socio-economical sustainability analysis and Mine.io ecosystem business models and update roadmap» fall under WP7 «Market shaping, scale-up business models and socioeconomic impact & Mine.io outreach and awareness generation».

WP7 is the WP that handles the future exploitation and promotion of the project results and activities concluded in all other WPs of the project. Having said that, WP7 includes horizontal activities of the project which require input from all consortium partners to be effectively executed and delivered.

T7.1 and T7.2 are more closely related to the technological WPs (mainly WP 2-6) and the tasks involving the project pilots, where the exploitable assets and solutions proposed by Mine.io are tested and validated.

2 MINE.IO TAXONOMY OF EXPLOITABLE ASSETS AND IPR CLAIMS

Section 2 presents the categorisation of exploitable assets, table mappings, IPR ownership and claims, as well as the proposed exploitation pathways.

2.1 TAXONOMY AND TABLE MAPPING OF EXPLOITABLE ASSETS

In the table below, all exploitable assets of Mine.io which have been identified are listed.

No.	Asset's title	Short description of the asset	Related to Technology
1	Mine.io advanced aerial electromagnetic AI-assisted analysis	An advanced aerial magnetometer AI-assisted analysis module is a sophisticated system designed to enhance the detection, measurement, and interpretation of magnetic fields from an aerial platform, such as drones or aircraft. This asset integrates several technologies to improve the accuracy, efficiency, and effectiveness of magnetic surveys, commonly used in geophysical explorational studies. AI-Assisted Analysis: Artificial intelligence algorithms process the magnetic data collected, identifying patterns, anomalies, and significant features. AI helps in filtering noise, enhancing signal interpretation, and providing predictive modelling. Data Integration and Visualization: Advanced software tools integrate magnetometer data with other geospatial datasets, offering 3D visualization, mapping, and real-time analysis capabilities.	Geophysical Surveying: The module is primarily related to technologies used in geophysical exploration, including seismic, gravity, and electromagnetic methods. Drones and UAVs (Unmanned Aerial Vehicles): Utilized as platforms for carrying the magnetometer equipment, drones offer flexible and efficient data collection over diverse terrains. Machine Learning and Artificial Intelligence: AI technologies, including machine learning algorithms, are central to analyzing and interpreting large datasets, improving the accuracy of detecting magnetic anomalies. Geospatial Information Systems (GIS): These systems are crucial for managing, analyzing, and visualizing the spatial data collected by the magnetometer. Remote Sensing: The module also relates to remote sensing technologies that collect and interpret data from a distance, often used in conjunction with satellite imagery and aerial photography.

2	Aerial electromagnetic data collection – UAV hardware prototype	ACC will design a vertical take-off and landing (VTOL) drone for geophysical-electromagnetic measurements. More specifically, it will be designed for mapping and monitoring hard-to-access sites such as abandoned mines, remote tailings, and underground locations. This novel UAV will be highly adaptable, with the ability to accommodate different operational specifications.	UAV Prototypes
3	Muography data analysis of tailings/ stockpiles	Development of an underwater muon detection system aimed at density studies of targets situated in underwater environments such as water-filled open pit mines, tunnels, and galleries. This development is a collaborative effort between MUO, INE, and WRCP. Execution of muography (density) measurements at Pilot Sites 3 (Lavrion, Greece) and 6 (Malaposta, Portugal). Density data will be used to characterise geological density distributions in rocks that are difficult to study with other means due to their location in flooded environments. These data are crucial for assessing the economic potential of a closed mine (e.g., imaging of an ore body) and detecting structural features such as faults in the rock volume.	Components of MUO: a) Water- and pressure-proof casing and shielding for the underwater muon detector. b) Water- and pressure-proof plugs and cabling.
4	3D SLAM (Simultaneous Localization and Mapping)	We can distinguish 3 different levels in the presented asset with different value contributions: 3D SLAM System: This core component combines sensors (e.g., LiDAR, cameras, IMUs (Inertial Measurement Unit)) to simultaneously create a 3D map of an environment and determine the module's position within that map. It performs real-time data fusion, integrating input from multiple sensors to generate accurate and detailed 3D maps. Analysis module: Artificial intelligence algorithms process the 3D spatial data, enhancing map accuracy, identifying features, and improving the localization and mapping process. AI aids in object recognition, obstacle detection, and path planning. Data Visualization and Management software: Advanced	Robotics: The module is fundamental in robotic navigation, enabling robots to understand and interact with their environment autonomously. Autonomous Vehicles (AV): Utilized in self-driving cars and drones, this technology allows vehicles to navigate safely and efficiently by creating and interpreting real-time 3D maps. Computer Vision: Integrated cameras and vision algorithms are essential for recognizing and interpreting visual data, contributing to accurate mapping and localization. Sensor Fusion: The module relies on combining data from

		software tools provide 3D visualization of the mapped environment, allowing for interactive exploration and analysis. These tools facilitate data management, integration with other datasets, and real-time updates.	various sensors (LiDAR, cameras, IMUs) to improve the robustness and accuracy of the SLAM process. Artificial Intelligence and Machine Learning: AI and ML algorithms are crucial for analyzing sensor data, improving mapping accuracy, and enhancing object detection and recognition capabilities. Augmented Reality (AR): In AR applications, SLAM technology is used to overlay digital content onto the real world by accurately mapping the environment and tracking the user's position. Geospatial Information Systems (GIS): These systems manage and analyze spatial data, providing a framework for integrating SLAM-generated maps with other geospatial datasets.
5	Muography detector	Muography detectors are capable to measure cosmic muon flux, which is related to the total integrated density of the overburden. Execution of muography (density) measurements at Pilot Sites 3 (Lavrion, Greece) and 6 (Malaposta, Portugal). Density data will be used to characterise geological density distributions in rocks that are difficult to study with other means due to their location in flooded environments. These data are crucial for assessing the economic potential of a closed mine (e.g., imaging of an ore body) and detecting structural features such as faults in the rock volume.	Cosmic muon tracking detectors are based on multi-wire proportional chamber or scintillator technologies.
6	Muon telescope	Development of an underwater muon detection system aimed at density studies of targets situated in underwater environments such as water-filled open pit mines, tunnels, and galleries. This development is a collaborative effort between MUO, INE, and WRCP.	Components of MUO: a) Water- and pressure-proof casing and shielding for the underwater muon detector. b) Water- and pressure-proof plugs and cabling.

7	Underwater vehicle for in-situ exploration in flooded mines	An untethered and autonomous underwater robot will be developed for in-situ exploration in flooded mines. It will be capable of autonomous 3D mine mapping, geological, mineralogical and spatial information gathering, with autonomous exploration functionalities and artificial intelligence to extend the exploration capabilities in untethered modes and produce high-resolution 3D density maps of underground targets. HW (Hardware): Multibeam sonar, scanning image sonar, 6 cameras, 6 structure light systems, 6 DOF movement. Cage support system for data transfer and commands. SW (Software): High-precision navigation, autonomous exploration algorithms, mapping algorithms Advanced sonars can produce precise 3D map of the environment. Meanwhile, structure light systems produce even more precise map of up to millimetres at the cost of range and visibility. All the precise 3D information and navigation will feed the autonomous exploration algorithms in order to map and explore the environment and return to the cage system for more updates/upload data.	Autonomous navigation and exploration, 3D mapping
8	X-RAY Scattering and Computed Tomography	X-ray scattering: X-ray Diffraction (XRD) technology, particularly wide angle X-ray scattering (WAXS), is used to determine the crystal structure of solid-state materials. An innovative energy dispersive XRD system aims to improve efficiency in mineralogical analysis by utilising a broad X-ray spectrum, reducing analysis times from hours to seconds. This system requires minimal sample preparation and does not need a clean laboratory environment. It is used to analyse the mineralogical composition of drill cores. This involves determining the crystal structure of various minerals within the cores, which helps in identifying and quantifying the types of minerals present. X-ray computed tomography:	

		X-ray computed tomography (CT) in mining applications provides a non-destructive three-dimensional (3D) visualisation and quantification of rock volumes, deformation, and ore in drill cores. Unlike traditional two-dimensional (2D) surface observations, this technology offers a more comprehensive understanding of in-situ textural settings. Advances in lab-based X-ray computed micro-tomography have enabled high-resolution imaging. Based on a deep-learning approach, the system can enhance the ability to create detailed 3D models of drill cores.	
9	Autonomous Operation on Vehicle – Obstacle detection and navigation algorithms	Provide the miner with control and the ability to track the movements of the vehicle with extremely high accuracy in underground scenarios or where GPS (Global Positioning System) is not available, as the vehicles will feature obstacle detection and navigation capabilities.	Automated tracking system and navigation
10	Electrification system	The electrification system consist of an inductive energy transfer system allowing to recharge the batteries of an electric truck while driving in the mine environment. The ENRX Wireless Dynamic Charging is composed of two parts, a primary side and a secondary side, which are electro-magnetically coupled, comparable to a normal transformer. The stationary primary side consists of a Track Supply and one or several Charge Coils arranged in segments with specific lengths. The mobile secondary or vehicle side consists of one or several Pickups and Rectifiers, which are installed in the vehicle.	The dynamic wireless charging development proposed by ENRX for the mining application will provide a final product that will be part of the ENRX family products, based on its Dynamic wireless charging system tested at different test locations in Germany and Belgium with varying vehicles like trucks, buses, delivery vans, and passenger cars at charging capacity of 220 kW, while driving 80 km/h with an overall efficiency of more than 90%.
11	Workload Scheduling and Planning	Two software modules for optimization of two different processes: · Optimization of the processes involving displacements outside the mine. · Optimization of the mining task per shift.	The technologies used in developing this assets include: · Heuristic Optimization · Evolutionary Algorithms · Agent simulation · API (Application Programming Interface) Rest web services

12	Drill behaviour CPS (Cycle Per Second)	The developed model will be used to filter and process MWD (Measurement While Drilling) parameters using AI and ML tools and techniques.	MWD technology, Artificial Intelligence and Machine Learning
13	Blockchain-based Traceability System	The traceability system will track and trace the movement and history of mining waste throughout its lifecycle. It will provide a means to monitor and record the origin, production, distribution, and other relevant information about the mining waste and their components: · It will collect and store different data related to the mining waste, such as its source, production methods, quality control checks, etc. · It could trace and monitor the asset's location and status (if applicable). · It could be easily integrated with other systems or databases if needed (i.e., quality control).	The traceability platform will be based on Blockchain technology, taking advantage of the secure features Blockchain provides (enhanced security, decentralization, data integrity, high availability, data transparency, data long term maintenance, intermediates removal). Meunier, S. (2018). Blockchain 101: what is blockchain and how does this revolutionary technology work? In Transforming climate finance and green investment with Blockchains (pp. 23-34). Academic Press. Koens, T., & Poll, E. (2018). What blockchain alternative do you need? In Data Privacy Management, Cryptocurrencies and Blockchain Technology: ESORICS 2018 International Workshops, DPM 2018 and CBT 2018, Barcelona, Spain, September 6-7, 2018, Proceedings 13 (pp. 113-129). Springer International Publishing.
14	Smelter DT	Advanced sensors will give data that are not yet available during a metallurgical process or can only be obtained through additional sampling. The progress of the metallurgical process can be evaluated with the help of this additional information. This enables the end user to improve process control. At the end, material and energy savings are achieved with improved valuable metal recovery.	The sensors give assessment of the bath fluid dynamics via acoustic measurements, will give information about slag and metal phase properties via radar and LIBS (Laser-Induced Breakdown Spectroscopy) measurements and should be able to measure the oxygen partial pressure directly within the furnace atmosphere. The sensor data is fed into a digital twin which can be used

			to control the metallurgical process.
15	Photonic IT (PIT) System	An advanced Photonic-IT System with the ML algorithms and software together with AI-assisted analysis module is designed to enhance the technological flotation process and to monitor and estimate the metal content in the flotation froth. This should be the start way for flotation process optimization. This asset integrates several technologies to improve the accuracy, efficiency, and effectiveness of the estimation of a metal content in the flotation froth. The ML algorithms will enable us to optimize the image processing of the flotation froth and to construct the optimal set of image descriptors. AI-Assisted Analysis: AI algorithms will process the data of registered images, identifying significant features responsible for the estimation of a metal content in a froth. AI helps in filtering noise, enhancing signal interpretation, and providing predictive modelling. Data Integration and Visualization: Advanced software tools will display the predicted estimated data of a froth content in the selected flotation machine.	Flotation technology: Estimation of a metal content in a flotation froth. Photonics and IT technology: application of various photonic sensors and dedicated software for registration of a flotation froth images, image processing, construction of a set of image descriptors, construction of the ML and AI algorithms and software for froth content estimation. Machine Learning and Artificial Intelligence: ML and AI technologies, including machine learning and artificial intelligence algorithms, are central to analyzing and interpreting large datasets based on the froth images.
16	Dual-Energy XRT (X-ray transmission) Smart Sorting	Dual energy XRT sorting is a pre-concentration method used in the mining industry to enhance the efficiency of ore processing. This technique involves the use of X-ray technology to identify and separate valuable minerals from waste material. By detecting differences in the effective atomic number of materials, X-ray based sorting allows for the early removal of low-grade ore, reducing the volume of material that needs to be processed in downstream operations and improving overall resource utilisation. DE XRT smart sorting extends XRT sorting by deep learning-based image analysis models like EfficientNet, ResNet, and YOLO. Those models have shown impressive performance in the classification and object detection of natural images, and initial results suggest these models also excel in analysing X-ray data.	Digitalized geophysics - electric resistivity imaging (ERI) and passive seismic imaging (SI). Robust and scalable data acquisition and processing platform for subsurface monitoring of tailings embankments.

17	Optimizing Primary and Secondary Production with Hybrid Modeling	A physics-informed machine learning Framework to optimally operate mineral processing plants.	Digitalization, modelling and control of plant wide processes.
18	Automated Geophysical Data Collection and Interpretation	A general framework for integrating geophysical methodologies and techniques (geoelectric and seismic geophysics) to collect subsurface field data and convert it into information models useful to mining engineers managing mining wastes, as well as stakeholders and authorities promoting a responsible and modern mining industry. The technique has potential uses in the mining, oil and gas sectors, and water resources management. Broad application fields include structural health monitoring (monitoring of stability, ground deformation, safety), environmental monitoring, subsurface hazard prediction, disaster response management (insurance assessment)	Digitalised geophysics - electric resistivity imaging (ERI) and passive seismic imaging (SI). Robust and scalable data acquisition and processing platform for subsurface monitoring of tailings embankments.
19	Workflow Automation Engine for Mines with Blockchain Integration	MINE.IO Workflow Automation Engine (WAE) is a system designed to streamline operational and business workflows in the mining and raw materials sectors. It leverages blockchain technology and smart contracts to execute work orders and record secure, immutable collaboration agreements. The WAE includes a Graphical User Interface (GUI) for managing data policies and integrating analytics to track decisions and materials across the value chain. The engine automates processes such as peer-to-peer business agreements and work order validation through its Business Process Orchestrator, which communicates with the Smart Contract Manager via HTTP and REST API calls.	Related to Workload Scheduling and Planning
20	Predictive Maintenance for Sustainable Mining	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 platform, being developed by ICCS.
21	Social Sustainability of Mine.io Technological Solutions	N/A	applied to all Mine.io outcomes

22	IoT Integration and Hybrid Architecture	Build a remote sensing, edge computing, edge continuum/dementalized communication system that will constitute the connection platform to be used in order to integrate various IoT devices and data sources in pilot sites and will be built on top of currently available IoT platforms and standards.	Based on FIWARE, MongoDB, Python programming language, Tensorflow
23	Centralized Big Data Cloud for Networked IioT in Mining Operations	The Big Data Platform is designed to handle large-scale data efficiently, support geographically distributed deployments, accommodate huge data storage needs, and ensure centralized, location-agnostic data management. Also, it supports the following functionalities: • Data sharing • Pilot driven requirements data storage • Incremental deployment • Variety of data types • Variety of communication patterns (synchronous and asynchronous) • Discoverability	A variety of technologies are used for the implementation of the big data platform. Regarding data storage, Hadoop, PLM, MongoDB, pilot driven repos are utilized. Concerning the integration with other components, Kafka messaging system is selected for the manipulation of the real-time streaming data and for the asynchronous communication. Furthermore, node.js is used for the implementation of the REST API, supporting the synchronous communication. Finally, java and node.js are used for the implementation of the connectors between the individual data storages and the rest big data platform modules. For the deployment of these components, Docker environment is selected.
24	Data Protection Strategies for the Mine.io Ecosystem	Implementation of a System that allows for privacy preserving ABAC Policy evaluation	Identity and Access Management, Attribute Based Access Control
25	Digital Twin PLM Module for Mine.io with Open Standard Interoperability	EDMtruePLM is a cloud capable IoT repository with rich data exchange capabilities. The repository contains product data, reference data, and system data for the projects that are in work. Archived models are referenced and stored outside the repository. The repository also contains the queries to update and retrieve the data. These queries are accessible for client applications by web services.	Based on the Product Lifecycle Support (PLCS) schema and Express language developed by ISO

Table 1 - Description of Exploitable Assets

The table below shows the assets, mapping them to the relevant WP/T, pilot/activity within the project's DoA, and the responsible partner.

Each asset has been categorised in one or more of the following categories:

- F – Framework/Architecture/Blueprint/Guideline
- M – Module/Platform Element/Side Product
- D – Dataset/Knowledge base
- P – Pilot/Use Case/Application
- I – Intangible/Patent/Publication

No.	Asset title	Source of Asset	Introduced by Partner	Related to Pilot	Category
1	Mine.io advanced aerial electromagnetic AI-assisted analysis	WP4 / T4.7	USAL	EL, FI	D
2	Aerial electromagnetic data collection – UAV hardware prototype	WP4 / T4.7	ACC	EL, FI	M
3	Muography data analysis of tailings/ stockpiles	WP3/T3.1	MUO	EL, PT	D
4	3D SLAM	WP4 / T4.7	USAL	EL	D
5	Muography detector	WP3/T3.1	WRCP	EL	M
6	Muon telescope	WP3 /T3.1	MUO	EL, PT	M
7	Underwater vehicle for in-situ exploration in flooded mines	WP3 / T3.2	INESC	PT	M
8	X-RAY Scattering and Computed Tomography	WP3 / T3.3	FhG / AGH	Laboratory testing	M / D
9	Autonomous Operation on Vehicle – Obstacle detection and navigation algorithms	WP3 / T3.4	ACC	DE (Underground Mine)	(Software) M
10	Electrification system	WP3 / T3.4	ENRX	DE (Underground Mine)	M
11	Workload Scheduling and Planning	WP3 / T3.5	TEC	DE (Underground Mine)	(Software) M
12	Drill behaviour CPS	WP3 / T3.6	LTU	DE (Underground Mine)	(Software) M / D
13	Blockchain-based Traceability System	WP4 / T4.1	TEC	To be defined	(Software) M / D
14	Smelter DT	WP4 / T4.2	TUBAF	DE (Processing plant)	D
15	Photonic IT (PIT) System	WP4 / T4.3	LITR	PL (PIT System testing in LITR laboratory and next in KGHM Mineral Processing Plant)	(PIT System and Software) F / M / D / I
16	Dual-Energy XRT Smart Sorting	WP4 / T4.4	FhG	Laboratory testing	(Software) M / D
17	Optimizing Primary and Secondary Production with Hybrid Modeling	WP4 / T4.5	LTU	DE (Processing plant)	(Software) M / D

18	Automated Geophysical Data Collection and Interpretation	WP4 / T4.6	OULU	FI	(Software) M / D
19	Workflow Automation Engine for Mines with Blockchain Integration	WP5 / T5.1	FRO	To be defined by partner	(Software) M
20	Predictive Maintenance for Sustainable Mining	WP5 / T5.2	ICCS	DE (Underground Mine)	(Software) M
21	Social Sustainability of Mine.io Technological Solutions	WP5 / T5.3	POLITO	ALL	F / (Software) M
22	IoT Integration and Hybrid Architecture	WP5 / T5.4	HMU	ALL	F
23	Centralized Big Data Cloud for Networked IIoT in Mining Operations	WP5 / T5.5	INNOV	ALL	F
24	Data Protection Strategies for the Mine.io Ecosystem	WP5 / T5.6	LTU	ALL	F
25	Digital Twin PLM Module for Mine.io with Open Standard Interoperability	WP5 / T5.7	JOTNE	ALL	F / D

Table 2 - Mapping and Categorisation of Exploitable assets

The bar chart below summarizes the exploitable assets' categories.

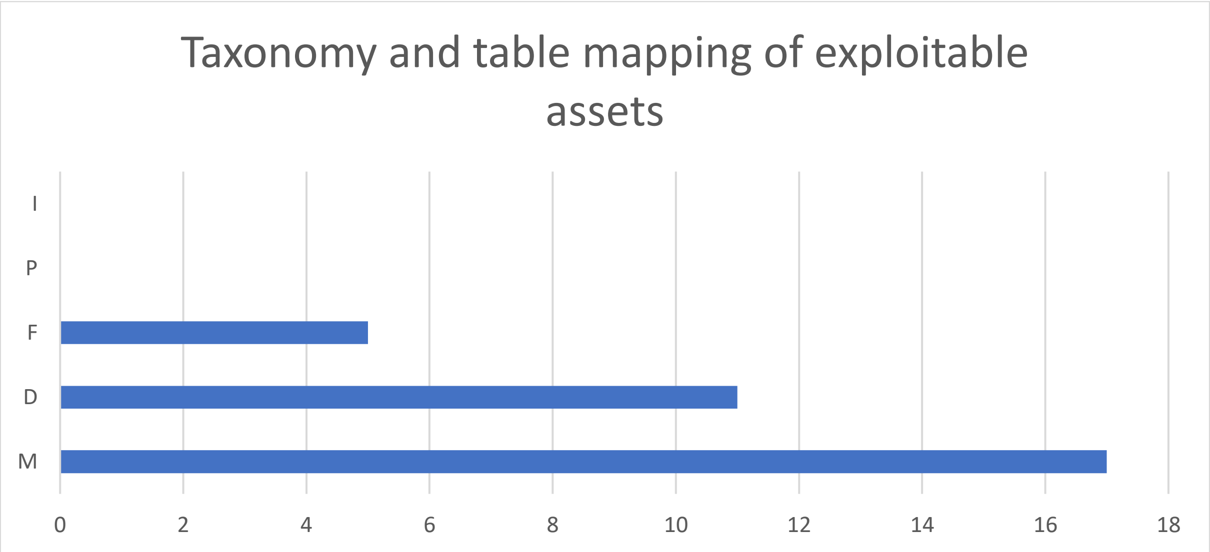

Figure 1 - Bar Chart Analysis of Asset Categorisation

2.2 Preliminary IPR Management – Contributions, Background and Foreground

This section presents the contribution of each partner to the exploitable assets, as well as the knowledge they bring and develop to these assets during the Mine.io project.

All consortium partners have contributed their preliminary claims, any updates will be included in the next iteration of this deliverable.

Below, an explanation of each category letter, followed by a table containing the collected information, is provided.

C – Contribution: Partner claiming to have provided (or intending to provide) substantial assistive Contribution on the Asset development). Of course, a partner must be participating in the task of that asset with non-zero person hours.

B - Background: Partner claiming to have brought Background knowledge on the Asset that existed before the project. It may have also been mentioned in the Consortium Agreement Appendix (CA) as background knowledge.

F - Foreground: Partner claiming to have developed (or intending to develop) new Foreground knowledge while working on the asset, that they can/will exploit.

No.	Asset title	Short partner's name	Category
1	Mine.io advanced aerial electromagnetic ai-assisted analysis	USAL, ACC	C, F
2	Aerial electromagnetic data collection – UAV hardware prototype	ACC	C, B, F
3	Muography data analysis	MUO	C, B, F
4	3D SLAM	USAL	C, F
5	Muography detector	WRCP	C, B, F
6	Muon telescope	WRCP, MUO, INE	C, B, F
7	Underwater vehicle for in-situ exploration in flooded mines	INESC UGR	C,B,F C,B, F
8	X-RAY Scattering and Computed Tomography	FhG/ AGH	C, B, F
9	Autonomous Operation on Vehicle – Obstacle detection and navigation algorithms	ACC	C, B, F
10	Electrification system	ENRX	B, F
11	Workload Scheduling and Planning	TEC, FRON	C, B, F
12	Drill behaviour CPS	LTU	B, C, F
13	Blockchain-based Traceability System	TEC, FRON	C, B, F
14	Smelter DT	TUBAF	F
15	Photonic IT (PIT) System	LITR	C, B, F
16	Dual-Energy XRT Smart Sorting	FhG	C, B, F
17	Optimizing Primary and Secondary Production with Hybrid Modeling	LTU	C, F

18	Automated Geophysical Data Collection and Interpretation	OULU	B, F
19	Workflow Automation Engine for Mines with Blockchain Integration	FRON	F
20	Predictive Maintenance for Sustainable Mining	ICCS	F
21	Social Sustainability of Mine.io Technological Solutions	POLITO ALL	N/A
22	IoT Integration and Hybrid Architecture	HMU	B, F
23	Centralized Big Data Cloud for Networked IIoT in Mining Operations	INN	B, F
24	Data Protection Strategies for the Mine.io Ecosystem	LTU	C, F
25	Digital Twin PLM Module for Mine.io with Open Standard Interoperability	JOTNE	F

Table 3 - IPR Management - Contributions, Foreground and Background Claims

It is noted that this table reflects the opinions/claims by the consortium partners and how they view their own contributions, regardless of who actually owns the assets. In addition, new foreground knowledge may be developed while working on assets owned by other partners. Finally, the fact that a partner has contributed to one of the assets does not necessarily mean that they see potential for exploitation or that there are intentions to further exploit an asset.

The bar chart below presents an overview of the contribution of the assets. As presented, most partners will develop new foreground knowledge while working on the Mine.io exploitable assets.

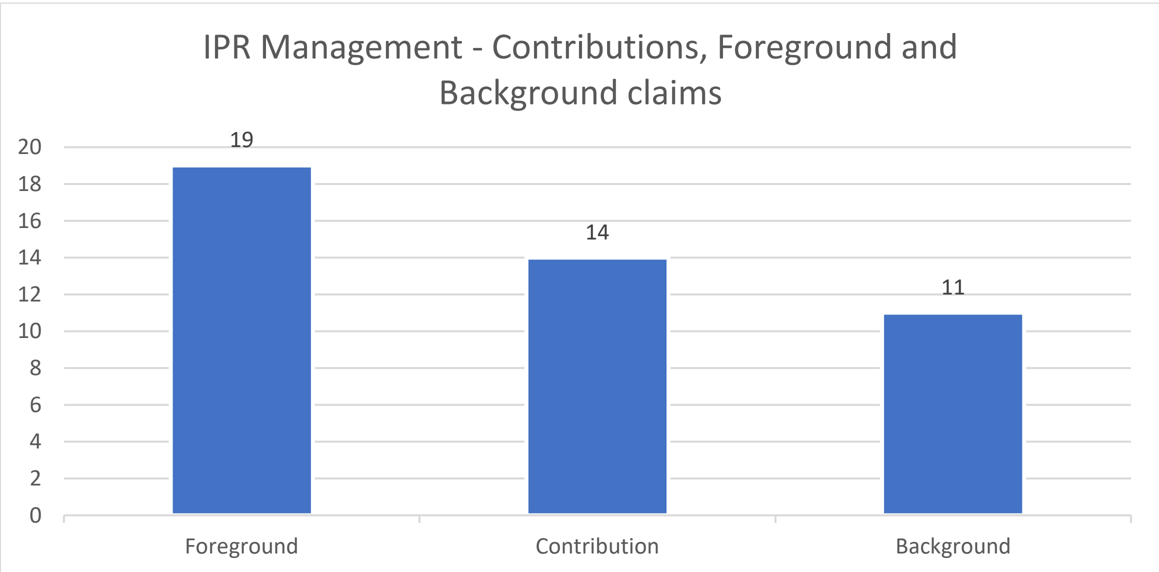

Figure 2 - IPR Management Analysis

2.3 PARTNER EXPLOITATION PATHWAYS AND INTENTIONS

For each exploitable asset, the following listed possible exploitation paths (which are not mutually exclusive) were provided and the partners had to consider in order to complete the survey table with the objective of carrying out a market study.

The table presents the mere partners' intentions (non-mandatory) and hypothetical paths they may follow in terms of exploitation. These paths include selling to the market, technical creation, assembly, production, licensing, further research, publications, datasets, other services and training.

The letter codes for exploitation pathways and intentions are referenced below:

- **M - Market (Sell)**: A partner aims to sell the asset by leveraging their existing sales channels to promote it to potential clients. Ownership of the asset is not required, as the partner may obtain permission to sell through a license agreement with the asset owner. This represents a selling intention.
- **C - Technical Creation, Assembly, Production**: A partner seeks to produce the asset, whether for selling it independently or through third-party channels. This reflects a technical development intention.
- **L - License**: A partner is interested in licensing or assigning their asset or related knowledge to third parties for an agreed fee, allowing others to exploit it. This is common for universities without a dedicated sales force.
- **I - Internal**: A partner anticipates opportunities for internal use, expansion, or replication of the asset in the future. This is typical for pilots, demonstrators, factories, or adoption in company product lines.
- **R - Research Further**: A partner plans to conduct further research, including journal or conference publications and other research initiatives.
- **P - Publish (Non-Scientific)**: A partner intends to publish non-scientific materials related to the asset, such as handbooks, best practices, presentations, multimedia content, videos, books, charts, etc.
- **D - Dataset**: A partner aims to exploit datasets related to the asset through online marketplaces, for experiments, further research, consulting services, and other purposes.
- **T - Training**: A partner wants to develop training materials and/or offer training services or methods (such as online tests, webinars, printed materials, etc.) related to the asset.
- **S - Services**: A partner is willing to provide complementary services, including consulting, lectures, technical integration, support, maintenance, and other added value services associated with the main asset.

- **G - Governmental**: A partner has connections and can promote the asset to governmental bodies, contribute to EC policy recommendations, or engage with standardization bodies and associations.

No.	Asset title	Short partner's name	Category
1	Mine.io advanced aerial electromagnetic ai-assisted analysis	USAL, ACC	C, D, I, R
2	Aerial electromagnetic data collection – UAV hardware prototype	ACC	M, C, I, R, P, S, G
3	Muography data analysis	MUO	C, L, I, R, P, D, S
4	3D SLAM	USAL	C, D, I, R
5	Muography detector	WRCP	C, I, R, P, D, T
6	Muon telescope	WRCP, MUO	C, I, R, M, P, S, D
7	Underwater vehicle for in-situ exploration in flooded mines	INESC UGR	L,R D, T, S
8	X-RAY Scattering and Computed Tomography	FhG AGH	 R
9	Autonomous Operation on Vehicle – Obstacle detection and navigation algorithms	ACC	M, C, I, R, P, S, N, G
10	Electrification system	ENRX	M, C, I, R, P
11	Workload Scheduling and Planning	TEC	C, L
12	Drill behaviour CPS	LTU	R, D
13	Blockchain-based Traceability System	TEC	C, L, R
14	Smelter DT	TUBAF	I, R
15	Photonic IT (PIT) System	LITR	C, I, R, P, T
16	Dual-Energy XRT Smart Sorting	FhG	
17	Optimizing Primary and Secondary Production with Hybrid Modelling	LTU	C, R
18	Automated Geophysical Data Collection and Interpretation	OULU	C, L, R, P, D, T
19	Workflow Automation Engine for Mines with Blockchain Integration	FRON	C, L, R, S
20	Predictive Maintenance for Sustainable Mining	ICCS	C, L, R
21	Social Sustainability of Mine.io Technological Solutions	ALL	R

22	IoT Integration and Hybrid Architecture	HMU	C, R
23	Centralized Big Data Cloud for Networked IIoT in Mining Operations	INN	L, S
24	Data Protection Strategies for the Mine.io Ecosystem	LTU	R, S
25	Digital Twin PLM Module for Mine.io with Open Standard Interoperability	JOTNE	M, C, G

Table 4 - Partners' exploitation pathways and intentions

The figure below presents an analysis of the partners' input regarding the exploitation pathways and their intentions. It is evident that for the majority of the exploitable assets, the intention is to proceed with further research and technical creation. The remaining categories had a lower participation rate.

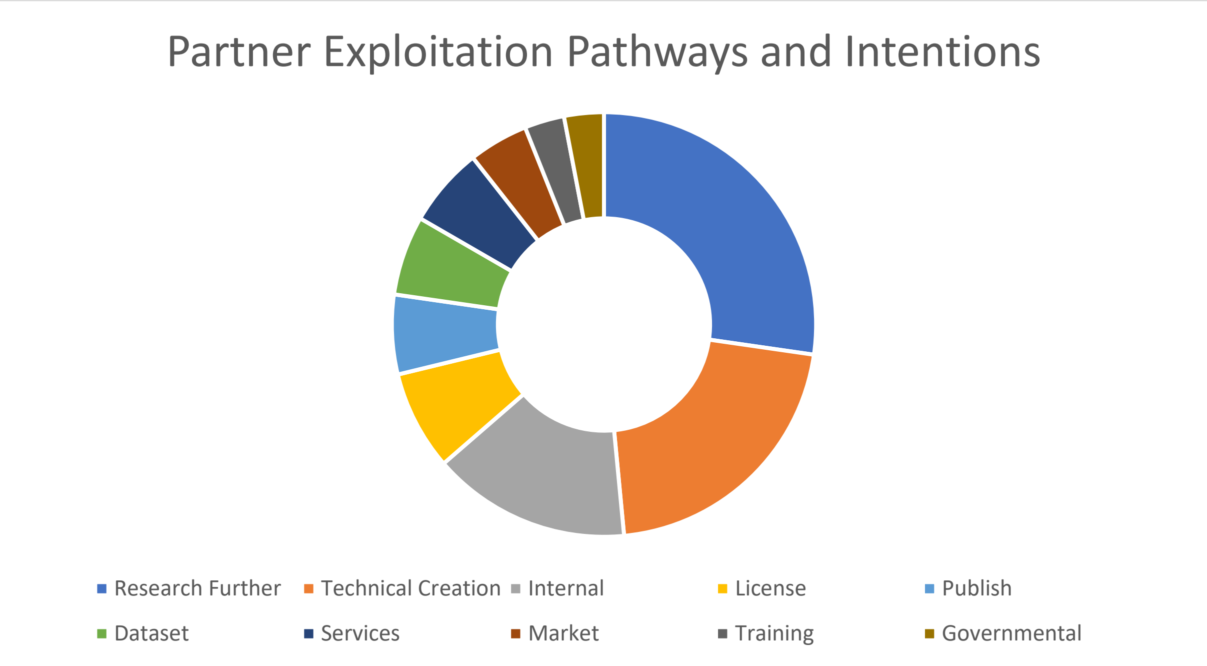

Figure 3 - Analysis of partners' input on exploitation pathways and intentions

3 MARKET ANALYSIS AND IMPACT ASSESSMENT

In order to present an analysis of the market, ACC shared a Partners fill-in form as previously described. Using the information provided an initial market analysis is outlined below.

3.1 BUSINESS ENVIRONMENT

The Mine.io solution will create an innovative digital ecosystem and a systematic framework for applying Industry 4.0 in mining operations. It will cover the entire mining value chain, including resource exploration, extraction, processing, waste management, and post-mining activities, with an emphasis also on electrification solutions. Mine.io envisions an innovative cloud services system and a ground-breaking mining ecosystem focused on sharing, interconnection, and open collaboration. To achieve this, Mine.io aims to:

- Develop a unified data infrastructure
- Create a collaborative platform ecosystem to enhance data openness and sharing
- Improve the cooperative environment among mining enterprises
- Systematize the fundamental processes of the mining industry
- Optimize assets and process equipment through embedded predictive analytics and data-driven optimization procedures
- Integrate cyber-virtual and cyber-physical systems
- Automate and robotize mining exploration and production processes
- Ensure sustainable mining and post-mining management

3.1.1 Benefits to the Industry, Market Players and to the Economy

Each partner provided specifics about the benefits of its own technology by completing the ''Partners fill-in form'' (ANNEX 2) and provided their input with respect to what they consider:

- To be potentially beneficial to the economy from the adoption of their innovation and/or technology development;
- Who will gain from utilizing this technology and how this benefit manifest and
- How will these technologies bring about substantial/ beneficial changes to their respective industry.

Summarising some of the key benefits for utilising Mine.io technologies are:

- Automation reduces manual tasks and errors, leading to more efficient operations, higher production outputs, and lower operational costs.
- While automation can replace some manual jobs, it creates new high-skilled employment opportunities in tech-driven roles, fostering a more skilled workforce.
- Blockchain implementation enhances supply chain visibility, optimising operations, reducing waste, lowering costs, and improving product quality, which boosts business competitiveness.
- Investing in cutting-edge technologies drives innovation, motivating businesses to advance and fostering an environment where new ideas and businesses thrive.

- Smart contracts ensure transparent, secure, and immutable transactions, improving trust, reducing fraud, and enhancing regulatory compliance.
- Improved efficiency and traceability contribute to better environmental and social outcomes, such as reduced waste, better resource management, and improved labour condition monitoring in supply chains.
- Integrating workflow automation and smart contracts into the mining and raw materials sectors promises to revolutionize these industries by significantly enhancing operational efficiency, reducing costs, and improving supply chain transparency. These technologies enable streamlined processes, better compliance with regulatory standards, and foster trust among stakeholders through secure and immutable transaction records.

Mine.io digitalised framework will pave the way for innovation, allowing companies to explore new business models and markets. Ultimately, this technological solutions not only boost competitiveness and profitability but also support environmental sustainability and ethical practices, aligning with broader societal values.

The sectors that will benefit from using the Mine.io technologies are:

- Mining Companies: Automated processes and smart contracts streamline operations, reduce costs, increase output, improve regulatory compliance, and build trust with partners and customers.
- Suppliers and Customers: Enhanced supply chain management ensures reliable delivery times, better product quality, and increased trust across the entire value chain.
- Employees and Job Seekers: Automation creates new roles in management, development, and oversight while offering opportunities for workers to upskill or reskill in response to evolving technologies.
- Regulators/Governments: New technologies simplify regulatory compliance, aid enforcement and oversight, and enhance industry competitiveness, contributing to economic growth.
- Environment & Society: Improved material tracking fosters sustainable practices, reduces environmental impact, and ensures ethical sourcing through transparent supply chains.

3.2 Policy Plans and Regulatory Framework

For the Mine.io project, it is essential to consider the relevant legal and regulatory framework that could affect the developed technological innovations. These laws typically cover aspects such as technical requirements, restrictions on the technology's application and use, and any necessary registration or licensing procedures. It's crucial to navigate these regulations to ensure compliance and smooth implementation of the innovations within the specified legal boundaries.

A short summary of the following legal frameworks have been identified to govern the use and deployment of the technologies intended for the project. These regulations and standards will be further examined by JOT under T7.5 Standardisation and Empowering European Mining.

3.2.1 Unmanned Aircraft Vehicles (UAVs)

EU Regulations 2019/945 of 12 March 2019 on Unmanned Aircraft System (UAS) and on third country operations of UAS and 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft (Regulations) set the framework for the safe operation of drones in European skies (EU and EASA Member States).

The regulations have been enforceable in all EU Member States since 31 December 2020, and all UAS manufacturers and operators must ensure they comply with their provisions. The regulations do not distinguish between leisure or commercial activities for operations or UASs; a risk-based approach is followed taking into account the weight and other specifications of the UAS, as well as the type of operation it is intended to be completed.

3.2.2 GDPR

The General Data Protection Regulation (GDPR) on a European level and the adoption of the GDPR on a national level and/or any additional local directives or guidelines issued to that extent is applicable to the Mine.io activities and solutions.

The GDPR was formally adopted by the European Parliament in May 2016, and replaced the 1995 GDPR, applying to all 28 EU member states, effective from May 2018. Entities are subject to the GDPR as far as they process personal data of EU data subjects for their goods or service offerings in the EU and/or for the monitoring of the behaviour of EU data subjects taking place within the EU.

The GDPR is a game-changer for organisations. It has introduced new requirements and more stringent data protection challenges, backed by extremely high fines for non-compliance. GDPR is not just a compliance exercise. There are major strategic implications that could bring market opportunities and competitive advantage for those who plan as appropriate, or potential revenue loss for those who fail to react. Companies developing and deploying surveillance technologies must comply with GDPR to ensure the lawful and transparent use of data collected by their systems.

3.2.3 AI act by European Commission

The AI act aims to provide AI developers, deployers and users with clear requirements and obligations regarding specific uses of AI. Regulation (EU) 2024/1689 of the European Parliament and of the council of 13 June 2024 laying down harmonised rule on artificial intelligence and amending Regulations has been passed recently and will be examined further if required during the next versions of this deliverable.

3.2.4 Other

- National Laws in Europe (Supplementary to GDPR):

- National Data Protection Laws (e.g., Germany's Bundesdatenschutzgesetz, France's Loi Informatique et Libertés)

EU member states have national data protection laws that complement the GDPR by addressing specific provisions. These laws may introduce additional requirements, such as appointing data protection officers, conducting data protection impact assessments, or obtaining specific approvals for processing activities. Compliance with both national laws and the GDPR is essential for organisations using technologies like WAEs, Smart Contract Managers, and Permissioned Blockchains.

- Legal Frameworks Outside Europe:
  - United States (US):

Uniform Electronic Transactions Act (UETA) and Electronic Signatures in Global and National Commerce Act (ESIGN)

- UETA and ESIGN provide the legal foundation for recognizing and enforcing electronic transactions and signatures in the US. These laws validate electronic contracts, including those supported by technologies like WAEs and smart contracts, ensuring that digital transactions are as enforceable as traditional paper-based ones. Regulatory bodies, such as the SEC and CFTC, may also provide guidelines for specific uses of smart contracts in areas like mineral rights, environmental compliance, and commodity trading.
- Australia:
- Corporations Act 2001 (Cth) and Electronic Transactions Act 1999 (Cth)
- The Corporations Act 2001 governs corporate transactions in Australia, while the Electronic Transactions Act 1999 provides legal recognition to electronic contracts and signatures. Businesses using workflow automation technologies and smart contracts must comply with these laws to ensure the enforceability of their digital agreements and transactions.
- Other Countries:

Many other countries have their own legal frameworks governing electronic transactions, data protection, and technology use. Depending on the jurisdiction, these laws may include electronic commerce regulations, data protection laws, and industry-specific rules that impact the use of WAEs, Smart Contract Managers, and Permissioned Blockchains. Organisations must understand and comply with these laws to mitigate legal risks and ensure their technological solutions are enforceable.

3.2.5 Automation in Underground Mining

- Technical Specifications:
  - Governments often set technical standards for autonomous vehicles (AVs), including the algorithms that drive them. These standards may cover performance, safety, cybersecurity, and interoperability with other vehicles and infrastructure. Standards such as ISO 26262 (for automotive functional

safety) and ISO/PAS 21448 (for safety of the intended functionality) are commonly referenced. The algorithm must demonstrate reliability in diverse conditions and the ability to handle emergencies.

- Limitations on utilisation and use of the technology:
- Limitations can include the level of autonomy permitted (e.g., Level 3, 4, or 5 as defined by the SAE International's levels of driving automation). Some jurisdictions may restrict the use of autonomous vehicles in certain areas or under specific conditions (like extreme weather). There may be requirements for human oversight or the ability to take control in certain situations.
- Registration and/or Licensing Required for the Technology:
- Autonomous vehicles, including those using specific driving algorithms, might need special registration to identify them as such. Manufacturers or operators of these vehicles may be required to obtain special licenses or permits. There could be additional requirements for reporting and data sharing with regulatory authorities, particularly concerning the performance and safety of the autonomous systems.
- Other considerations:
- Liability and insurance laws are critical, especially in determining who is responsible in the event of an accident – the manufacturer, software developer, or operator. Data protection and privacy laws are also essential, given the significant amount of data collected and processed by autonomous driving systems.

- National/EU Policy Plans
  - EU Regulations/Directives

The EU is actively promoting intelligent transport systems, including autonomous driving. The European Commission's strategy on automated and connected mobility emphasizes safety, legal framework, and a single European market for mobility. EU-wide regulations often focus on safety standards, cybersecurity, and data protection (GDPR considerations). The Vienna Convention on Road Traffic, amended in 2016, allows for autonomous vehicles if they can be overridden or switched off by a driver.

  - National Law vs. EU Law

Individual EU countries may have specific regulations that vary slightly, especially regarding testing and deployment. For instance, Germany passed legislation allowing driverless cars on public roads, setting detailed guidelines for operation. France has been testing autonomous vehicles and may have specific requirements for testing and use on public roads.

- Third Countries/Beyond Europe
  - USA

The USA has a more decentralised approach, with individual states setting their own rules for autonomous vehicles. The federal government provides guidelines but not strict regulations, focusing on safety and innovation. States like California, Arizona, and Nevada have been frontrunners in creating an environment conducive to testing and deployment.

- Australia

Australia has been progressively updating its laws to accommodate autonomous vehicles. The National Transport Commission (NTC) is working on regulatory reforms to allow more extensive testing and use of autonomous vehicles. State-level laws also play a significant role, with states like South Australia taking the lead in legalizing and regulating the testing of these vehicles.

- Other Countries

Countries like Japan and South Korea are also heavily investing in and regulating autonomous driving technology. Japan has specific guidelines and has been a leader in testing autonomous vehicle technology, focusing on safety and integration with existing infrastructure. South Korea has dedicated parts of its cities for testing autonomous vehicles and is actively developing legal frameworks for their use.

3.2.6 Static and Dynamic Wireless Charging

- National/EU Policy Plans Supporting/Promoting Utilisation of Such Technologies

EU Regulations/Directives:

EU Industrial Emissions Directive (IED) 2010/75/EU

The IED aims to reduce harmful industrial emissions across the EU, including those from mining activities, by requiring industrial installations to operate using Best Available Techniques (BAT).

The directive encourages the adoption of cleaner technologies, such as ENRX's wireless charging systems, to reduce emissions from the mining industry's vehicle fleet. [1]

- National Law Differences:

National Mining Regulations (varies by country)

National regulations may impose specific technical requirements for mining equipment, including vehicles and associated charging infrastructure, to ensure safety and environmental protection.

Static and Dynamic Wireless Charging technology must tailor its wireless charging solutions to comply with these country-specific regulations, which could affect system design and operation.

Country-Specific Government Mining Department Website

[1] EUR-Lex, ''DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL'', *Official Journal of the European Union*, November 24, 2010, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

- Third countries/beyond Europe:
  - USA:

Mine Safety and Health Administration (MSHA) Standards

MSHA provides regulations for all US mine safety and health, including certification and operation standards for electrical equipment.

Compliance with MSHA standards is mandatory for Static and Dynamic Wireless Charging system to be used in US mining operations, influencing system safety features and potentially installation procedures.[2]

https://www.msha.gov/regulations

  - Australia:

Australian Standards for Mining (AS/NZS 3007)

These standards outline electrical installation and maintenance requirements in Australian mines to ensure safe operations.

Static and Dynamic Wireless Charging system must meet AS/NZS 3007 standards to be implemented in Australian mines, which may require specific certifications and adherence to stringent safety protocols. [3]

3.2.7 Digital Twin based on Open Standards ISO 10303 PLM Repository

ISO 23247: This standard provides an overview and outlines the general principles of a digital twin framework for manufacturing.

This law can be used to implement the Digital twin framework in the mining industry. The DT framework breaks down into systems and subsystems according to the entity-based reference model which can be referred while Digital Twin creation in case of machinery or components involved in the Mining industries.[4]

ISO 10303: This standard describes and defines about the model-based engineering and application protocol for its representations. Digital Twin based PLM solution implemented with reference to this standard.[5]

3.2.8 Multisensor geophysics for surveillance of tailings facilities

EU Rules for Mining Waste:

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[2] ''Regulations'', Mine Safety and Health Administration, https://www.msha.gov/regulations

[3] '' Electrical equipment in mines and quarries - Surface installations and associated processing plant'', *Standards Australia,* 2013, https://www.standards.org.au/standards-catalogue/standard-details?designation=as-nzs-3007-2013

[4] '' Automation systems and integration — Digital twin framework for manufacturing
Part 1: Overview and general principles'', *ISO*, 2021, https://www.iso.org/standard/75066.html

[5] '' Industrial automation systems and integration — Product data representation and exchange
Part 242: Application protocol: Managed model-based 3D engineering'', *ISO*, 2022, https://www.iso.org/standard/84667.html

EU rules aim to ensure that mining waste is properly managed to avoid damaging the environment. As such, the geophysics-based technology for monitoring & surveillance of mining waste in Mine.io fosters and follows these comprehensive set of laws, guidelines and reports that seek responsible and resilient technology for managing mining wastes and protect environmental values such as water, air, soil. The most relevant frameworks include:

- Best Available Techniques reference document Management of Waste from Extractive.
- Directive 2006/21/EC on the management of waste from the extractive industries.
- Directive 2006/21/EC Commission report on the implementation.
- Environmental Protection Act 527/2014 (The Mining Waste directive and Finnish legislation)
- Land Act 555/1981 (The Mining Waste directive and Finnish legislation)
- Seveso III Directive: operational tailings disposal facilities containing dangerous substances.
- Directive 2000/60/EC Water Framework Directive.

3.3 TECHNOLOGY TRENDS

For the Market Analysis within the Mine.io project, it is crucial to pinpoint existing technology trends. These insights serve as pivotal indicators for predicting the success of innovations in the relevant market sector. Understanding current trends provides a foundational reference point for stakeholders to strategies long-term plans for promoting and leveraging these technologies effectively. Moreover, insights into market trends facilitate the identification of potential industry shifts, presenting valuable opportunities for partners to align with emerging trends rather than resist them.

For each of their assets, the partners were requested to provide the following information:

- Why is there a move towards utilisation of their technology.
- Which industries would benefit the most from the use of their technology.
- What is the current market growth for their technology.
- What are the current uses and what could be the future uses of their technology.
- Whether any steps have been taken towards utilizing/developing/regulating the technology.

The partner's inputs are currently being evaluated and analysed and will be presented in detail in the second version of this deliverable.

3.4 COMPETITIVE LANDSCAPE

Properly identifying solution comparison criteria is crucial for benchmarking the solution against competitors, highlighting its competitive advantages, and defining its unique value proposition for prospective owners/operators. These criteria should be as universal as possible across competing solutions, reflecting the key technical or functional characteristics and major investment and exploitation issues. They must be customer-oriented, defined based on customers' use cases, needs, and constraints (financial, technical, skill-related, etc.). Additionally, the criteria should be tailored to the customers' profiles—emphasizing technical criteria for technical customers and functional criteria for less technical customers.

To identify competitors of the Mine.io solution and technologies and to outline the competitive landscape, input was gathered from partners who pinpointed current/potential competitors and alternative solutions. The analysis began with assessing competition intensity using Michael Porter’s “Five Forces” strategy tool (Dr. Gerard H. Th. Bruijl, *The Relevance Of Porter’s Five Forces In Today’s Innovative And Changing Business Environment, June, 2018*). This involved evaluating competitive rivalry by identifying the number and quality of rivals, assessing supplier power by considering the number and uniqueness of suppliers and the cost of switching, and examining buyer power by looking at the number and size of buyers, their switching costs, and their ability to dictate terms. Additionally, the analysis considered the threat of substitution, where easy and cheap alternatives could undermine profitability, and the threat of new entry, evaluating how easily new competitors could enter the market, associated costs, and regulatory barriers.

Partners provided insights based on these questions to accurately map the competitive landscape relevant to their innovations.

The competitive landscape of Mine.io technology is relatively subdued due to the niche market and the novel nature of the technology. Although there are a few existing solutions with similar functionalities, comprehensive comparisons are challenging due to the lack of detailed information about these alternatives.

Buyer power is significant because the primary customers are large mining companies with substantial influence. While these buyers can potentially switch to alternative solutions, such transitions are complex and costly, involving not only financial investments but also the establishment of new trust relationships. The threat of substitution is mitigated by extensive industry experience and established partnerships, which strengthen the provider's position. Meanwhile, the threat of new entrants is low due to the specialized nature of the market and the challenges associated with accessing proprietary data and building credibility in such a closed industry.

Further analysis will be carried out regarding the competitors and stakeholders of Mine.io solutions that will be examined further in the second version of this deliverable.

3.5 SWOT Analysis

A SWOT analysis is a strategic planning method used to evaluate the Strengths, Weaknesses, Opportunities, and Threats associated with a project or business venture. It involves defining the project's or venture's goals and identifying internal and external factors that could aid or impede their achievement. Regularly examining the environment in which an organisation operates helps anticipate changing trends and incorporate them into the decision-making process. Given the dynamic and increasingly competitive environments institutions face, it is crucial for both the Project and the future planning of each partner in terms of exploiting and commercializing technologies to assess how these environments might influence them. SWOT analysis assists organisations in analysing their competitiveness and identifying factors that could either enhance or threaten their objectives.

A preliminary SWOT analysis of the overall Mine.io solution was carried out and is presented in D7.2 Mine.io Communication and dissemination strategy and plan (1.0) which was submitted in M4 (please refer to Table 1 of D7.2). This SWOT analysis provides a comprehensive overview of the project's internal and external factors that can impact its success. By considering these factors, the project team is able to develop a strategic plan that maximises the project's strengths, addresses its weaknesses, takes advantage of opportunities, and mitigates potential threats.

Under the activities of T7.1 a SWOT analysis was further developed and took into consideration the input by the consortium partners regarding their own exploitable technologies. The template used is provided in Table 5 below.

	Favourable Factors	Adverse Factors
Internal Factors	STRENGTHS *What do you do well?* *What unique resources can you draw on?* *What do other see as your strengths?*	WEAKNESSES *What could you improve?* *Where do you have fewer resources than others?* *What are others likely to see as a weakness?*
External Factors	OPPORTUNITITES *What opportunities are open to you?* *What trends could you take advantage of?* *How can you turn your strengths into opportunities?*	THREATS *What threats could harm you?* *What is your competition doing?* *What threat do your weaknesses expose you to?*

Table 5 - SWOT Analysis Template

According to the SWOT analysis carried out, Mine.io technologies and solutions possess several key strengths. These include the enhanced efficiency and automation by reducing manual intervention and errors, with smart contracts ensuring transactions and work orders are transparent, immutable, and verifiable. These technologies also facilitate transaction traceability, which fosters regulatory compliance and allows for customization to meet specific industry needs. Meanwhile, they support real-time monitoring, improving safety by enabling immediate responses to potential issues and facilitating predictive maintenance through data analysis from mining equipment. They reduce downtime and optimize maintenance schedules. All technologies contribute to increased operational efficiency by improving communication and data exchange, optimising resource utilisation, and reducing costs.

Additionally, they allow for real-time tracking of environmental conditions, ensuring miner safety by promptly identifying and addressing potential hazards.

Concurrently, these exploitable assets can further boost mining processes by reducing manual intervention and increasing efficiency. Leveraging IoT data for advanced analytics and artificial intelligence facilitates smarter decision-making and process optimization. Also, they enable more efficient remote monitoring and control, reducing the need for on-site personnel and improving safety. Additionally, technologies help mining companies meet evolving regulatory requirements related to safety and environmental standards, with new EU directives presenting research and funding opportunities.

On the other hand, Mine.io daces some weaknesses or challenges that need attention and will be examined further in the duration of the project. Such may include low TRL level in some technologies, the difficulty in collaboration with external partners such as equipment manufacturers and challenging environments for the deployment of technologies.

In the boarder context Mine.io has various opportunities like the streamline workflow automation, with potential for collaborations with technology providers, regulatory bodies, and other stakeholders to establish industry standards. Their scalability allows adaptation to other sectors, opening new markets, while its improved traceability and efficiency enhance sustainability and align with Environmental, Social, and Governance (ESG) criteria.

Mine.io nevertheless faces some threats that could impact its success. Rapid technological advancements might render its current solutions obsolete, necessitating continuous updates and investments to stay competitive. Increased reliance on digital systems also raises the risk of cyber-attacks and data breaches. The fast-paced evolution of mining technologies compounds these risks, making it essential to frequently update infrastructure. Additionally, the extensive collection and use of data may lead to privacy concerns, potentially resulting in regulatory scrutiny or public distrust. Resistance from employees who are accustomed to traditional processes and broader industry practices could also hinder the adoption of new technologies. Furthermore, changing regulations around digital contracts and the possibility of competitors developing superior or more cost-effective solutions present additional challenges.

A summary of the SWOT Analysis carried out is set out below.

Strengths

The technologies enhance efficiency by reducing manual intervention, which speeds up processes and minimise errors. Streamlined processes and automation lower operational costs while also allowing for workflow customization based on industry-specific needs. The real-time monitoring capabilities improve safety and operational efficiency by enabling proactive responses to potential issues and optimising maintenance schedules. The technologies also benefit from decades of operational experience and a highly skilled workforce, combined with advanced infrastructure that supports efficient and safe operations, all of which are scalable at a relatively low investment cost.

Weaknesses

Implementing a comprehensive system across different operational environments is challenging, particularly in terms of compatibility with existing systems. Specialised knowledge is required, making extensive training or hiring of experts necessary, which adds to the costs. Additionally, the interconnected nature of the system introduces security vulnerabilities that need to be addressed. Initial setup costs for infrastructure, training, and system integration can be financially demanding. There is also a dependency on strong and consistent network connectivity, making operations vulnerable to disruptions. Lastly, stringent regulatory requirements further complicate implementation.

Opportunities

The system presents opportunities for pioneering new industry standards through potential collaborations with various stakeholders. The scalability of the system makes it adaptable to new markets and sectors, thus broadening its applications. There are also opportunities to improve sustainability and ethical practices, aligning with environmental and social governance (ESG) standards. Furthermore, evolving regulations related to green practices present avenues for research funding and innovation. The system's data capabilities open doors for advanced analytics, remote monitoring, and enhanced automation, offering continued improvements in operational efficiency and decision-making.

Threats

Rapid changes in technology could render the system outdated, requiring continuous investment to stay current. The increased reliance on digital systems also raises the risk of cyber-attacks, which could lead to security breaches and regulatory scrutiny. Employee resistance to new technologies and changes in regulations may impede adoption. Competitive pressures and economic downturns could reduce investment in innovation. Additionally, the dependence on external suppliers for key components introduces risks of supply chain disruptions, which could affect system reliability and operational continuity.

3.6 Business Model Canvas and Value Proposition Canvas

3.6.1 Business Model Canvas

The Business Model Canvas (BMC) is a strategic management tool that delineates the essential activities, requirements, objectives of the Mine.io solution. Comprising nine building blocks, the BMC comprehensively addresses the core aspects of a business, including customers, infrastructure, services, and financial sustainability. These elements collectively shape the framework through which a company aims to achieve profitability. For these reasons, different sub-columns of the BMC will follow for the scope of the smooth operation of Mine.io project.

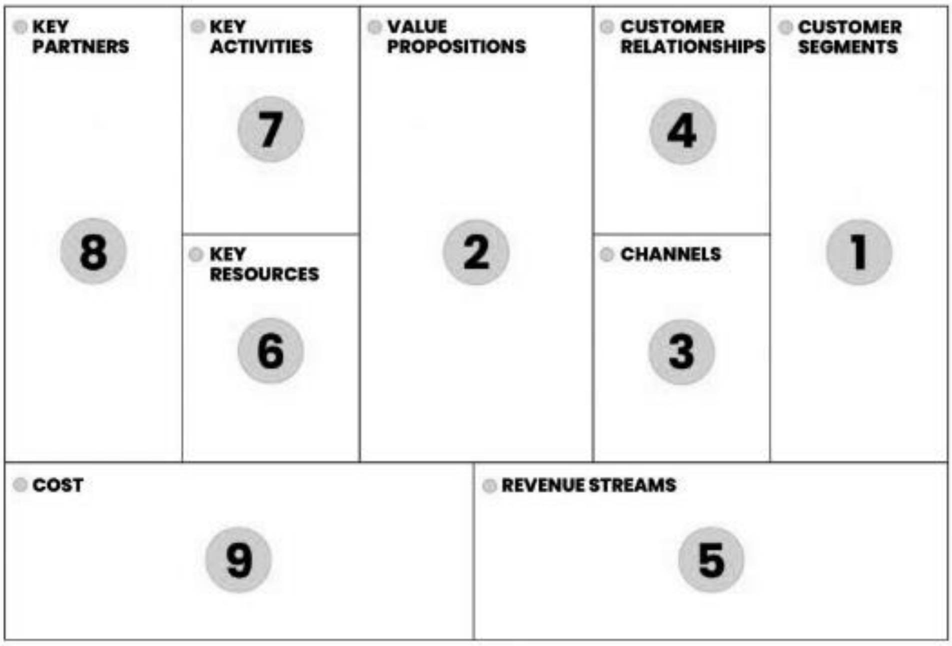

Figure 4 - Business Model Canvas

Customer segments

The customer segments building block encompasses all potential customers for the Mine.io Solution who are willing to invest in the product. These customers represent the identified target groups to whom Mine.io solution aims to deliver its value proposition. The consortium's objective is to analyse the requirements of the target audience and surpass their expectations. Following the project's initial scope and research, five customers segments have been discerned: EU agencies, national governments, mineral and mining companies, Technical Universities (Faculty of Mineral and Mining) and Robotic and automation companies' players of the mining industry are the primary prospective clients for Mine.io Solution. They potentially exhibit a keen interest in the comprehensive digital transformation of the mining ecosystem, encompassing the entire value chain-from exploration and extraction to waste management and post-mining activities. Leveraging Mine.io's innovative approach, these agencies can be guided towards adopting more sustainable and socially responsible practices. The proposed mining ecosystem encourages sharing, interconnection, and open cooperation, fostering a novel and collaborative approach to the mining industry.

National governments/ National public authorities play a crucial role as essential clients for the Mine.io solution. Within the EU member states, the absence of a mining digital ecosystem and a systematic structure for industry implementation in mining industrial environments highlights an opportunity for Mine.io's solution. By utilizing Mine.io, these governments/ authorities can assess their current tools, strategically evaluate the incorporation of additional technologies, and prioritize solutions that consider the perspectives of the workers involved in the mining sector.

Mine.io's capability to facilitate a smoother transition to a circular economy in the mining and metals industry makes it marketable to mineral and ore companies, as well as to mines and NGOs in more generally. The development of technological solutions that lead to more efficient recycling operations, reuse of waste streams and reduction of waste will play a critical role in the stages of mining in these companies. As the industry moves towards a more sustainable future, Mine.io stands as a beacon of innovation, offering a pathway to responsible and environmentally conscious mining practices.

At the opposite end of the market, technical universities, and more specifically, faculties of mining and metallurgy, are key customers not only because they are the bridge between the industry and the academic world, but also because they facilitate the continuous investment in knowledge.

Private IT firms and technology providers might consider Mine.io as a viable solution if they are interested in acquiring the technology for subsequent use. The development of onboard autonomous navigation software and associated AI software systems for environmental perception may be of interest to these customers.

The crucial role of UAVs in the project implementation attracts the interest of UAV hardware and software technology companies. For the same reason, sensor and technology organisation will also show interest in Mine.io technology. Generally, industry manufacturers will be interested in Mine.io’s technology and the combination of multiple technologies for different use cases. Additionally, the raw material supply chain sector may be interested in Mine.io solution to gain insights into Mine.io’s supply chain.

Civil societies as well as Mining and Mineral companies may show interest in the Mine.io solution due to its background and research area of interest. Mine.io provides various use cases that offer solutions at different stages of their work or study. The co-designed products, services, and scenarios of Mine.io promote sustainable behaviour over time.

Lastly, some Mine.io partners are also the end users of the Mine.io solution. The partners include TUB, UOULU, NTUA-AMDC, EFS, and KGHM, who will enhance the Mine.io platform through the novel tools, systems, and technologies. As end users, Mine.io partners will also contribute to the dissemination and communication aspects of the project.

Value proposition

Under the ‘’Value proposition’’ block, it is analysed what valueMine.io do delivers to the end-users and what problem does it solves. Mine.io provides customers with a novel mining digital ecosystem and a systemic structure for the implementation of Industry 4.0 (I4.0) in mining industrial environments. New emerging technologies and technical advancements in I4.0 add value to the entire solution. In conclusion, these digital mining technologies and systems offer a more sustainable solution to end-users.

Customer Relationships

The relationship between customers and Mine.io’s consortium is important for the project’s sustainability after its completion. Personal one-to-one interactions allow customers to express their comments and thoughts to stakeholders, fostering a better and more stable relationship. Additionally, the continuous events, including in-person and online workshops and expos, will further strengthen these personal relationships.

Key Resources

The resources in a project are significant for the successful implementation of the Mine.io project, whether they are financial resources or a specialized knowledge. The main financial resource of the Mine.io technology is the Horizon Europe or Euratom funding. Another one crucial resource is the human capital working on this project who are specialized in their subjects. As it is demonstrated in the canvas, another important resource is the expert and specific knowledge that Mine.io partners must have for the sections they are responsible for. It is essential to mention the important use of the mines and processing plants facilities where the pilots will be implemented. Last, as shown in the canvas, Intellectual property (IP) is a key resource of Mine.io due to the added value gained from the patents, copyrights, trademarks, and trade secrets through the project.

Key activities

The key activities of the Mine.io are the following five. The first one is the Optimization of Operations where partners need to enhance the performance of mining equipment and processes while minimizing environmental impact. Moreover, all operations should be optimized through real-time monitoring and management. The next activity is the resource management where this activity focuses on boosting profitability, as well as environmental and social performance. Third, is the employee safety including the development of safety measures in mining operations and fostering community trust and acceptance in the mining sector. Also, the supply chain management is the area that provide transparency into mining operations and improve the planning and scheduling of the material flows. Lastly, the creation of business models will leverage existing technologies in innovative ways to generate revenue.

Key Partners

The Key Partners block is potentially the most crucial component of the Mine.io project. The majority of it is derived from the Mine.io consortium, specifically from Legal Entities (LE) (GFT, MUO, IPT) and Small-Medium Entities (SME) (ACC, JOTNA, INNOV, FRONTIER, UGR) technology partners, Academic and Research partners (TUB, POLITO, UOULU, HMU, AGH, USAL, ICCS, TECNALIA, ITR, LEMAG, FHG) and End-users (TUB, UOULU, NTUA-AMDC, EFS, KGHM) comprising the consortium. These Mine.io partners are primarily responsible for executing the project. The remaining partners consist of National public authorities representing high-potential end-users candidates. Lastly, IT companies/technology providers are essential partners for the project due to the knowledge they can contribute to the mining domain.

Channels

The ''Channels'' building block serves as the interface between the Mine.io product and end-users. There are different ways to disseminate the Mine.io project, starting from the most accessible methods today, such as social media. LinkedIn and YouTube promptly share updates and general information on the Mine.io project. Additionally, the Mine.io Dissemination and Communication team has created a Website that presents the project, including various details not only about the project but also the consortium. Publications in scientific articles, press release and articles in e-newsletters will contribute to the dissemination of the project.

Another important method involves personal, face-to-face contact. The Mine.io project will be promoted by participating in events, exhibitions, conferences, and workshops. Lastly, printed material such as leaflets and banners will be distributed to cover all the potential ways of informing potential end-users.

Cost structure

The building block of the BMC that includes all the costs arising from implementing Mine.io technology cannot be missed. This building block is significantly correlated with two aforementioned blocks: key resources and key activities. The cost structure consists of six subcategories. The most obvious and costly category is Research and Development (R&D) expenses. R&D occupies the largest portion of this cost section, as Mine.io project based on it. The majority of the partners must conduct research to achieve the necessary results. Marketing and Advertising expenses are essential, as disseminating the project is a key activity among partners and potential customers. The Mine.io consortium must invest in this aspect to ensure the project's sustainable existence beyond its completion. Technology & IT Expenses encompass all the necessary equipment for implementing the Mine.io solution. In other words, this category includes all materials such as cameras, sensors, UAVs, UGVs (Unmanned ground vehicle) , etc. The Training and Development category covers costs associated with employee training programs, workshops, and development initiatives. Additionally, Financial Costs, as well as Travel and Subsistence Costs, include the participation of partners in project meetings, events, and salaries.

Revenue Streams

The sustainability of the project after its completion is strongly correlated with the revenues, which are essential for continuing to provide the Mine.io solution. One source of revenue is through direct sales with one-time payment. Another source of income is the maintenance and support fees, wherein Mine.io will provide technology maintenance for clients based on their specific needs. Additionally, a revenue stream will come from the training and consulting category, such as workshops. These training and consulting services will be provided by Mine.io, contributing significantly to the project's overall revenues.

Furthermore, income that will reinforce the sustainability of the project may be accessible from the services that Mine.io will provide to customers after the project's completion. The knowledge that Mine.io will generate is the driving force for further analysis in these fields or others by technical universities. As a result, this knowledge can be sold to polytechnics.

3.6.2 Value Proposition Canvas

Value proposition canvas (VPC) is a crucial business model that helps business make and position the right decisions about their products, services, technologies. It is a tool that forms the relationship between the product and the market. In other words, it enables businesses to align their strategies with market needs. Divided into two categories (Value proposition and

Customer profile from BMC) with three subcategories each, it demonstrates every part analytically.

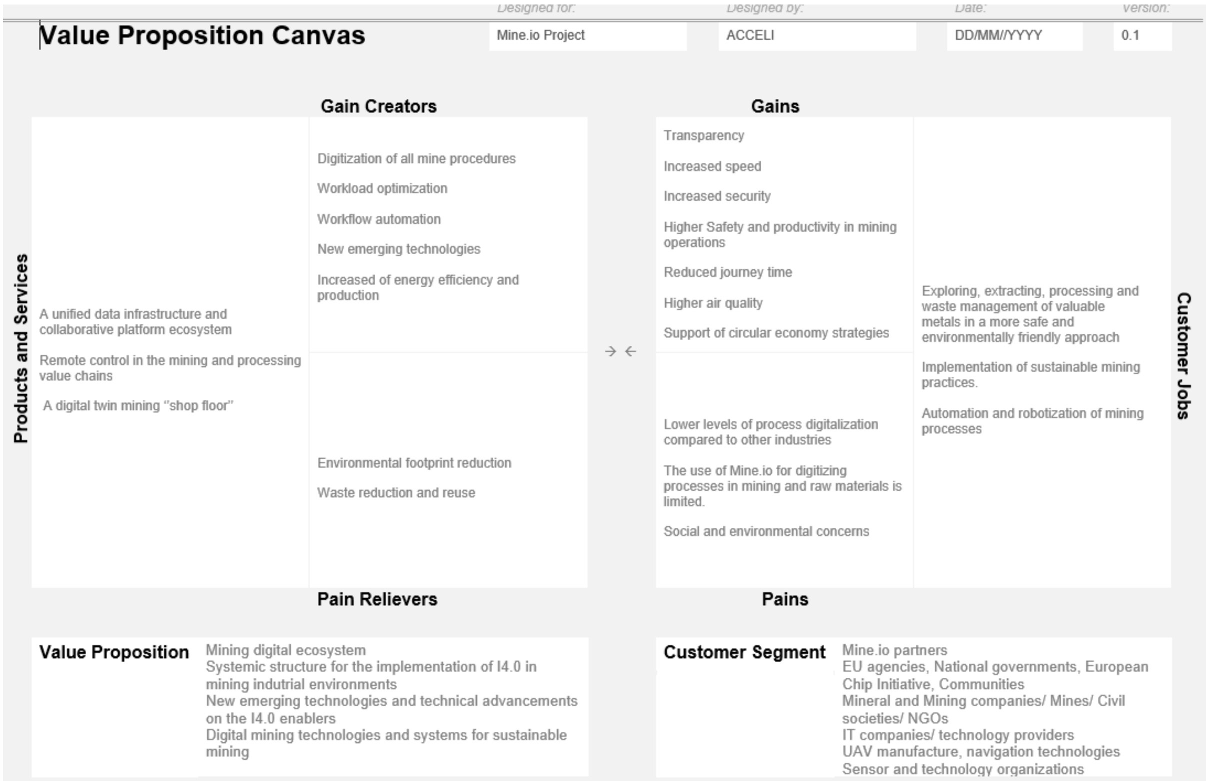

Figure 5 Value Proposition Canvas

The Customer profile is the first category, which consists of Customer jobs, Pains and Gains. Customer jobs subcategory includes the functional, social and emotional characteristics that consumers aim to accomplish, challenges they seek to overcome, and desires they want to fulfil. Pains, encompass all the problems, risks, and negative experiences and emotions, that customers can eliminate using the product. On the other hand, Gains includes all the positive feelings and experiences, such as the benefits and added value a customer receives from using the product. It shows the case from the end-user perspective, including both positives and negatives.

The Value proposition is the section of the diagram that analyses the product benefits, functionalities, and features with the aim of attracting customers and fulfilling their needs. It is divided into three parts, product and services, pain relievers and gain creators. Product and services as the words say is the category where the producer can list all the products, services and technologies. Pain relievers target factors that alleviate existing frustrations for the customer. Lastly, the gain creators box examines how the product or service will generate a customer gain and added value. Essentially, it encompasses everything that introduces something new or enhances the existing user experience.

Overall, it is a detailed tool that helps model the relationship between the two parts of Business Model Canvas: customer segments and value propositions. Below, the two building blocks are described in detailed. Value proposition canvas (VPC) is a crucial business model that helps business make and position the right decisions about their products, services, technologies. It is a tool that forms the relationship between the product and the market. In other words, it enables businesses to align their strategies with market needs. Divided into two categories (Value proposition and Customer profile from BMC) with three subcategories each, it demonstrates every part analytically.

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Overall, it is a detailed tool that helps model the relationship between the two parts of Business Model Canvas: customer segments and value propositions. Below, the two building blocks are described in detailed.

3.6.2.1 Products and Services

The value proposition is built around an advanced, integrated suite of solutions designed to transform the mining industry through cutting-edge technology. Central to this project is a unified data infrastructure and collaborative platform ecosystem that integrates diverse data sources for comprehensive data management and real-time collaboration. This platform enables stakeholders to make informed decisions and enhances operational efficiency across the entire mining value chain.

Additionally, it is provided remote control capabilities for the mining and processing value chains, allowing operators to manage operations from any location, ensuring optimal performance and safety. The digital twin mining 'shop floor' creates a precise virtual replica of the mining environment, enabling simulation, analysis, and optimization of operations. This interconnected ecosystem drives unprecedented levels of efficiency, safety, and sustainability, revolutionizing traditional mining practices.

Gain Creators

Mine.io will be the pioneering digital framework that digitizes all processes of mining production, including exploration, extraction, mineral processing, and waste management. Specifically, Mine.io will enhance the efficiency of all mine procedures through digitalization.

Additionally, the platform will support the electrification of underground trucks, promoting environmental sustainability. It will also offer workload optimization to improve working conditions. By utilizing these services, Mine.io will increase energy efficiency and production. Also, using new emerging technologies as for example the ''power transfer system'' it is allowed automated charging of vehicle batters without mechanical intervention and without galvanic contact providing a more safety working environment.

Pain Relievers

Electrifying the underground trucks, there is a reduction to environmental footprint (reduce of CO_2 emissions). Furthermore, increasing the predictability and cloud maintenance of mining equipment failures, there will be a positive effect on waste reduction and reuse.

3.6.2.2 Customer Segment

Gains

By obtaining the Mine.io platform, customers can reap several benefits. It ensures air quality through environmental monitoring and automates ore transportation, which reduces journey time and enhances cost efficiency. Additionally, the platform's mining planning tool provides end-to-end value chain visibility, enhancing the management of energy supply, waste recycling, and ore exports, thereby improving the environmental and social performance of the process and supporting circular economy strategies. Furthermore, Mine.io uses underwater robots to inspect abandoned areas in the mine, enhancing safety, transparency, and waste reduction. Lastly, Mine.io increases the speed and security of data acquisition campaigns in the field, including topographies and stockpile volume analysis.

Pains

Despite its gains, Mine.io faces negative outcomes, risks, and obstacles. The mining and metals sector is less digitized than other industries, leading to limited adoption of Mine.io. While blockchain technology improves visibility and business processes in many industries, its use in mining and raw materials remains limited. These challenges also raise social and environmental concerns for customers.

3.6.2.3 Customer Jobs

The customers of Mine.io are seeking a mining platform that transforms the industry through safer and more environmentally friendly methods. They aim to explore, extract, process, and manage waste sustainably to meet the need for eco-friendly practices. The platform should implement sustainable mining practices to ensure efficient operations with minimal environmental impact. Additionally, automation and robotization of mining processes are essential to enhance safety and efficiency by reducing human involvement in hazardous tasks. These advancements address the industry's demand for improved safety, environmental responsibility, and operational efficiency.

3.7 STAKEHOLDERS

The following is a non-exhaustive list of targeted costumers for the Mine.io solutions.

- End users/partners of the Mine.io consortium
- Local/regional/national authorities and policy makers/agencies – responsible for regulating mining operation and ensuring compliance with the environmental and social standards.
- Academic institutions – interested in the scientific and technical aspects of the project, its results and outcomes. Might also be interested in further exploitation of the research results and further development of the implementation of new technologies.
- SMEs/Industry operators/investors/startups – as part of the supply chain in the mining industry or developer of the related technologies may benefit from adopting solutions developed by the project, which could help them remain competitive in the market.
- Local communities – civilians living nearby the mines might be interested in the socio-economic and environmental impact of the newly implemented solutions.

During the course of Mine.io and based on the input received from the consortium partners, a more detailed list of stakeholders will be refined.

4 METHODOLOGY OF DEFINING SOCIO-ECONOMIC, ENVIRONMENTAL & COMPLIANCE ASPECTS FOR PILOTS

4.1 GENERAL

All Pilot Sites should define the indicators for the socio-economic and environmental sustainability of the Mine.io results, highlighting the importance of balancing social, economic, policy, and environmental objectives and assessing the impact of the Mine.io adoption and scaling-up initiatives.

In view of the above, we have prepared a template for the Pilots to fill. This template is our first approach to identify *socio-economic, environmental, and policy/compliance indicators* for each Stakeholder, and monitor and record the progress for each indicator through the Pilots' implementation.

In this section, the potential impacts that Mine.io results may have on the natural and anthropogenic sub-sectors are assessed in tabular form. That illustration focuses mainly on the following impact properties:

- Probability of occurrence
- Extent, with reference to the geographical area and / or the size of the affected population
- Intensity, with reference to the magnitude of the change
- Characteristic times (duration, repetition)
- Possibilities of prevention, avoidance, reversal, or minimization
- Collaborative or cumulative action with other effects from the project itself or from other projects or activities that have been developed or planned in the area.

The following color scale is used to display the different socio-economic, environmental and other impact properties:

Probability of occurrence	
Not Possible 0	(blue)
Low Possibility 1	(orange)
Large Possibility 2	(red)
Direction	
Positive Direction: +	+
Negative Direction	-
Neutral	0
Intensity	
Weak Effects 0	(blue)
Medium Effects 1	(orange)
Strong Effects 2	(red)
Magnitude	
Small 1	(blue)
Large 2	(red)

Timescale	
Short Term 1	
Medium Term 2	
Long term 3	
Reversibility	
Completely Reversable 0	
Partially Reversable 1	
Not Reversable 2	
Collaboration/Cumulatively	
No Collaboration 0	
Collaboration 1	

Potential Impact Sector	**Probability of occurrence**	**Direction - Intensity**	**Magnitude**	**Timescale**	**Reversibility**	**Collaboration**
Socio-economic Indicators						
Spatial planning - Land uses						
Cultural Heritage						
Involuntary resettlement						
Local Economy (including job opportunities)						
National Economy improvement						
Technical Infrastructure (e.g. roads, networks etc.)						
Research opportunities						
Workers/employees safety improvement						
Reuse opportunities (e.g. for a former mining site)						
Stakeholders' engagement						
Creation of additional value (e.g. metal extraction from waste)						
Environmental Indicators						
Climatic and bioclimatic characteristics (including carbon footprint)						
Morphological and landscape features						
Geological/Tectonic Characteristics						
Soil Characteristics						
Terrestrial Environment/Biodiversity						
Marine Environment						
Protected areas						
Air Quality						
Noise & Vibrations						
Electromagnetic Fields						
Terrestrial Surface Waters						
Groundwaters						
Sea Water						
Legal/Policy Indicators (Compliance)						

Environmental Legislation (including waste management)						
Occupational Health & Safety Legislation						
Labor Legislation						
Town Planning Legislation						

Table 6 - different socio-economic, environmental and other impact properties

4.2 PILOT SPECIFIC TEMPLATES

According to the methodology described above, a number of socio-economic, environmental, and policy/compliance indicators were identified for all Pilot Sites and illustrated in the following Tables. Those indicators should be monitored during the materialization of the Pilot in order to assess the potential impact of the Mine.io solution on specific natural and anthropogenic sub-sectors.

Potential Impact Sector	Probability of occurrence	Direction - Intensity	Magnitude	Timescale	Reversibility	Collaboration
Socio-economic Indicators						
Research opportunities	2	+	2	1	0	1
Workers/employees safety improvement	2	+	2	2	0	1
Reuse opportunities (e.g. for a former mining site)	1	+	1	2	0	1
Stakeholders' engagement	2	+	2	2	0	1
Environmental Indicators						
Geological/Tectonic Characteristics	1	+	1	1	0	1
Air Quality	2	+	2	2	0	1
Noise & Vibrations	2	+	2	2	0	1
Legal/Policy Indicators (Compliance)						
Occupational Health & Safety Legislation	2	+	2	2	0	1

Table: Socio-economic, environmental, & policy/compliance indicators for Pilot Site 1.2

Potential Impact Sector	Probability of occurrence	Direction - Intensity	Magnitude	Timescale	Reversibility	Collaboration
Socio-economic Indicators						
National Economy improvement	1	+	1	1	0	1

Technical Infrastructure (e.g. roads, networks etc.)	1	+	1	1	0	1
Research opportunities	2	+	2	1	0	1
Workers/employees safety improvement	2	+	2	2	0	1
Reuse opportunities (e.g. for a former mining site)	1	+	1	2	0	1
Stakeholders' engagement	2	+	2	2	0	1
Creation of additional value (e.g. metal extraction from waste)	2	+	2	2	0	1
Environmental Indicators						
Climatic and bioclimatic characteristics (including carbon footprint)	2	+	2	1	0	1
Air Quality	2	+	2	1	0	1
Legal/Policy Indicators (Compliance)						
Occupational Health & Safety Legislation	2	+	2	2	0	1

Table 7 - Socio-economic, environmental, & policy/compliance indicators for Pilot Site 1.1

Potential Impact Sector	Probability of occurrence	Direction - Intensity	Magnitude	Timescale	Reversibility	Collaboration
Socio-economic Indicators						
Research opportunities	2	+	2	1	0	1
Workers/employees safety improvement	2	+	2	2	0	1
Stakeholders' engagement	2	+	2	2	0	1
Legal/Policy Indicators (Compliance)						
Occupational Health & Safety Legislation	2	+	2	2	0	1

Table 8 - Socio-economic, environmental, & policy/compliance indicators for Pilot Site 2

Potential Impact Sector	Probability of occurrence	Direction - Intensity	Magnitude	Timescale	Reversibility	Collaboration
Socio-economic Indicators						
Spatial planning - Land uses	2	+	2	2	0	1
Cultural Heritage	2	+	2	2	0	1
Local Economy (including job opportunities)	2	+	2	2	0	1
National Economy improvement	1	+	1	1	0	1
Research opportunities	2	+	2	1	0	1
Reuse opportunities (e.g. for a former mining site)	1	+	1	2	0	1
Stakeholders' engagement	2	+	2	2	0	1
Creation of additional value (e.g. metal extraction from waste)	1	+	1	2	0	1
Environmental Indicators						

Climatic and bioclimatic characteristics (including carbon footprint)	2	+	2	2	0	1
Morphological and landscape features	2	+	2	2	0	1
Geological/Tectonic Characteristics	1	+	1	1	0	1
Soil Characteristics	2	+	2	2	0	1
Terrestrial Environment/Biodiversity	1	+	1	1	0	1
Terrestrial Surface Waters	2	+	2	2	0	1
Groundwaters	1	+	1	1	0	1
Legal/Policy Indicators (Compliance)						
Environmental Legislation (including waste management)	2	+	2	2	0	1
Town Planning Legislation	1	+	1	1	0	1

Table 9 - Socio-economic, environmental, & policy/compliance indicators for Pilot Site 3.1

Potential Impact Sector	Probability of occurrence	Direction - Intensity	Magnitude	Timescale	Reversibility	Collaboration
Socio-economic Indicators						
Cultural Heritage	2	+	2	2	0	1
National Economy improvement	1	+	1	1	0	1
Research opportunities	2	+	2	1	0	1
Reuse opportunities (e.g. for a former mining site)	1	+	1	2	0	1
Stakeholders' engagement	2	+	2	2	0	1
Creation of additional value (e.g. metal extraction from waste)	1	+	1	2	0	1
Environmental Indicators						
Climatic and bioclimatic characteristics (including carbon footprint)	2	+	2	2	0	1
Morphological and landscape features	2	+	2	2	0	1
Geological/Tectonic Characteristics	1	+	1	1	0	1
Soil Characteristics	2	+	2	2	0	1
Terrestrial Environment/Biodiversity	1	+	1	1	0	1
Terrestrial Surface Waters	2	+	2	2	0	1
Groundwaters	1	+	1	1	0	1
Legal/Policy Indicators (Compliance)						
Environmental Legislation (including waste management)	2	+	2	2	0	1

Table: Socio-economic, environmental, & policy/compliance indicators for Pilot Site 4

Potential Impact Sector	Probability of occurrence	Direction - Intensity	Magnitude	Timescale	Reversibility	Collaboration
Socio-economic Indicators						
Local Economy (including job opportunities)	2	+	2	2	0	1
Research opportunities	2	+	2	1	0	1
Reuse opportunities (e.g. for a former mining site)	1	+	1	2	0	1
Stakeholders' engagement	2	+	2	2	0	1
Creation of additional value (e.g. metal extraction from waste)	1	+	1	2	0	1
Environmental Indicators						
Climatic and bioclimatic characteristics (including carbon footprint)	2	+	2	2	0	1
Morphological and landscape features	2	+	2	2	0	1
Geological/Tectonic Characteristics	1	+	1	1	0	1
Soil Characteristics	2	+	2	2	0	1
Terrestrial Environment/Biodiversity	1	+	1	1	0	1
Terrestrial Surface Waters	2	+	2	2	0	1
Groundwaters	1	+	1	1	0	1
Legal/Policy Indicators (Compliance)						
Environmental Legislation (including waste management)	2	+	2	2	0	1

Table 10 - Socio-economic, environmental, & policy/compliance indicators for Pilot Site 3.2

Potential Impact Sector	Probability of occurrence	Direction - Intensity	Magnitude	Timescale	Reversibility	Collaboration
Socio-economic Indicators						
Local Economy (including job opportunities)	2	+	2	2	0	1
Research opportunities	2	+	2	1	0	1
Reuse opportunities (e.g. for a former mining site)	1	+	1	2	0	1
Stakeholders' engagement	2	+	2	2	0	1
Creation of additional value (e.g. metal extraction from waste)	1	+	1	2	0	1
Environmental Indicators						
Climatic and bioclimatic characteristics (including carbon footprint)	2	+	2	2	0	1
Geological/Tectonic Characteristics	1	+	1	1	0	1
Groundwaters	1	+	1	1	0	1

Legal/Policy Indicators (Compliance)						
Environmental Legislation (including waste management)	2	+	2	2	0	1

Table 11 - Socio-economic, environmental, & policy/compliance indicators for Pilot Site 5

Potential Impact Sector	Probability of occurrence	Direction - Intensity	Magnitude	Timescale	Reversibility	Collaboration
Socio-economic Indicators						
Local Economy (including job opportunities)	2	+	2	2	0	1
Research opportunities	2	+	2	1	0	1
Reuse opportunities (e.g. for a former mining site)	1	+	1	2	0	1
Stakeholders' engagement	2	+	2	2	0	1
Environmental Indicators						
Climatic and bioclimatic characteristics (including carbon footprint)	2	+	2	2	0	1
Geological/Tectonic Characteristics	1	+	1	1	0	1
Groundwaters	1	+	1	1	0	1
Legal/Policy Indicators (Compliance)						
Environmental Legislation (including waste management)	2	+	2	2	0	1

Table 12 - Socio-economic, environmental, & policy/compliance indicators for Pilot Site 6

4.3 COMPARISON BETWEEN PILOT SITES' FINDINGS

The most common indicators between the Pilots include:

- Research opportunities
- Occupational Health & Safety Legislation
- Workers/employees safety improvement
- Stakeholders' engagement

Bearing in mind the Mine.io concept and the fundamentals of Industry 4.0 in mining, those similarities were expected. Indeed, digitalization is about improving the safety of the working environment and also open new horizons for research and development opportunities. On the other hand, the effective Stakeholders engagement is considered crucial for the success of digitization concept.

The time scale for the improvement of all the above indicators is considered large (e.g. > 2 years) for all Pilot Sites. Indeed, the proposed process needs time to be established and be transferred from Pilot to Full Scale.

The magnitude of the indicators impact is also considered (positively) large for all Pilots. Finally, there is a collaboration between the indicators and their impact, for example Worker and Employees are considered, by definition, Stakeholders. Indeed, much of society as well as investors are demanding greater transparency concerning the true social, economic, and environmental impact of the mining activities. In order to meet the increasing social and environmental concerns, a resource optimization and digital transformation framework for enabling specific circular economy and "low-impact mining" strategies is required. One of the mine io project targets is to meet with those concerns.

Depending on the local conditions and the individualities of each pilot site, except for the common indicators, several different ones are observed. Nevertheless, with the exception of Pilot Site 2, air quality (including GHG reduction) is considered one of the key indicators to be monitored through the digitization process.

It is very important to define the type of parameters that will be measured and monitored during the indicators evaluation process and how those parameters can be linked to specific criteria. In the context of Mine.io, distinctive criteria will be established for each pilot. For all indicators, measurable values, (e.g. in form of KPIs), will be defined and presented in forthcoming deliverables.

5 CONCLUSIONS AND NEXT STEPS

Deliverable 7.1 outlines the preliminary framework for the "Market Shaping, Open Fair Repository, Scale-Up Business Models, and Socio-Economic Impact" of the Mine.io project. Through comprehensive collaboration among consortium partners, this deliverable presents a detailed exploitation list of all technical components within the project. Additionally, it provides a thorough market analysis informed by inputs from technical partners, resulting in a cohesive and strategic overview of the project's market positioning and potential socio-economic impact.

KERs and their possible exploitation pathways, will be identified and further analysed in the second and third version of this deliverable (D7.4 and D7.5). The integration of market analysis, socio-economic sustainability, and innovative business models highlights the project’s alignment with I4.0 trends and its commitment to fostering sustainable mining practices.

The methodologies employed, including SWOT analysis, competitive landscape assessment, and the Business Model Canvas, ensure a robust and strategic approach to market entry and exploitation. The deliverable also addresses the regulatory framework, technology trends, and potential customer segments, which are critical for the successful deployment and adoption of Mine.io innovations post-project.

In conclusion, deliverable 7.1 establishes a strong initial foundation for Mine.io's market strategy and socio-economic impact, setting the stage for further detailed analyses and strategic planning in subsequent phases of the project. The collaborative efforts and comprehensive analyses presented in this deliverable underscore the project's potential to drive significant advancements in the mining industry through innovative digital solutions and sustainable practices.

The reference list of socioeconomic and environmental impacts of mining gathered in the context of could be a starting point for the harmonization of indicators for a socioeconomic sustainability assessment. Our target was to prepare an initial approach to the socio-economic sustainability of the Mine.io results, highlighting the importance of balancing social, economic, and environmental objectives and assessing the impact of the Mine.io adoption in different Pilots. The outcomes of Pilots as presented in this study, will provide and enhance the cost-benefit analysis of Mine.io on the daily use of Mine.io holistic raw materials management. Pilots are “living organisms” and the evolution of the Mine io concept may differentiate indicators and their impact on the future. *An immediate next step will include the actual measurement of selected KPIs for each indicator so as to better monitor the socioeconomic and environmental impact of the Mine io on the different Pilot Sites.*

ANNEX 1 – LIST OF EXPLOITABLE ASSETS/TECHNOLOGIES

A Holistic Digital Mine 4.0 Ecosystem

Mine.io

T7.1 Market Analysis and Strategy definition

List and Analysis of Exploitable Assets

1. DEFINITIONS AND CLASSIFICATIONS OF EXPLOITABLE ASSETS/RESULTS

1.1 TABLE OF EXPLOITABLE ASSETS

Review the table below, revise the list of exploitable assets, and identify the partners responsible for them (introduce, lead or co-lead them according to the DoA).

Please assign “code letters” in the “category column” based on the provided codes. If it does not apply, leave the table unchanged.

Categories:

- F - Framework/Architecture/Blueprint/Guideline
- M - Module/Platform element/Side Product
- D - Dataset/ Knowledgebase
- P - Pilot/Use case/application
- I - Intangible/Patent/Publication

Mining value chain:

- Exploration
- Extraction
- Processing
- Waste Management

No.	Asset title	Source of Asset	Introduced by Partner	Related to Pilot	Category
1					
2					
3					
4					
5					
6					

7					

2. Description of exploitable assets/technologies

Please read and complete the table below, with the description and related technology for the exploitable assets.

No.	Asset's title	Short description of the asset	Related to Technology
1			
2			
3			
4			
5			
6			
7			

3. Intellectual property rights management, contributions, backgrounds & foreground claims

Each partner should review the table below, find the column that corresponds to their company, and enter the appropriate letter codes in the cells associated with the assets their organisation is interested in.

It is noted that all combinations of letters B,C,F are permitted.

Your organisation may have developed new knowledge while working on an asset that is partially or fully owned by another partner.

C – Contribution: Partner claiming to have provided (or will provide) substantial assistive Contribution on the Asset development). Of course, a partner must be participating in the task of that asset with non-zero person hours.

B - Background: Partner claiming to have brought Background knowledge on the Asset that existed before the PROJECT. It may have also been mentioned in the Consortium Agreement Appendix (CA) as background knowledge.

F - Foreground: Partner claiming to have developed (or will develop) new Foreground knowledge while working on the asset, that they can/will exploit).

No.	Asset title	Short partner's name	Category
1			
2			
3			
4			
5			
6			
7			

4. PARTNER EXPLOITATION PATHWAYS AND INTENTIONS

Please go to the table below and in the cells that correspond to assets of interest for your organization, add the applicable code letters that are listed below. All combinations of letters are allowed.

Please note that it is required for you to set your intentions on the exploitation path you intend to follow (not obliged to do however).

- **M - Market (Sell)**: A partner aims to sell the asset by leveraging their existing sales channels to promote it to potential clients. Ownership of the asset is not required, as the partner may obtain permission to sell through a license agreement with the asset owner. This represents a selling intention.
- **C - Technical Creation, Assembly, Production**: A partner seeks to produce the asset, whether for selling it independently or through third-party channels. This reflects a technical development intention.
- **L - License**: A partner is interested in licensing or assigning their asset or related knowledge to third parties for an agreed fee, allowing others to exploit it. This is common for universities without a dedicated sales force.
- **I - Internal**: A partner anticipates opportunities for internal use, expansion, or replication of the asset in the future. This is typical for pilots, demonstrators, factories, or adoption in company product lines.
- **R - Research Further**: A partner plans to conduct further research, including journal or conference publications and other research initiatives.
- **P - Publish (Non-Scientific)**: A partner intends to publish non-scientific materials related to the asset, such as handbooks, best practices, presentations, multimedia content, videos, books, charts, etc.
- **D - Dataset**: A partner aims to exploit datasets related to the asset through online marketplaces, for experiments, further research, consulting services, and other purposes.
- **T - Training**: A partner wants to develop training materials and/or offer training services or methods (such as online tests, webinars, printed materials, etc.) related to the asset.
- **S - Services**: A partner is willing to provide complementary services, including consulting, lectures, technical integration, support, maintenance, and other added value services associated with the main asset.

- **G - Governmental**: A partner has connections and can promote the asset to governmental bodies, contribute to EC policy recommendations, or engage with standardization bodies and associations.

No.	Asset title	Short partner's name	Category
1			
2			
3			
4			
5			
6			
7			

ANNEX 2 - PARTNERS FILL-IN FORM

A Holistic Digital Mine 4.0 Ecosystem

Mine.io
T7.1 Market Analysis and Strategy definition

Partner Fill-in Form

This document serves as a guide for all partners participating in Task 7.1: Market analysis and strategy definition on the preparation of Deliverable 7.1: Market shaping, open fair repository, scale-up business models and socio-economic impact - version 1.

All partners are required to fill-in all the relevant information below for the purposes of the deliverable.

The scope of this deliverable is to provide a detailed market analysis including the competitive landscape relevant to the technologies to be developed under the project and the proposed business models to be followed for the promotion of the technologies.

Please follow the guidelines and use the template hereinbelow to fill in any information.

To edit this document, please SAVE AS NEW DOCUMENT and follow the below naming convention:

[***NAME OF PARTNER]_Task7.1_version[1]***

Name of Partner:	
Name of technology you lead:	
Date:	

CONTENTS

1. SWOT ANALYSIS

Description: The SWOT (Strengths, Weaknesses, Opportunities, Threats) matrix is a tool to support strategic decision-making and help build a successful market access strategy for your product/service.

How to fill-in your SWOT matrix:

- Always keep in mind your objective, i.e. to commercialise your product/service. The template must be filled from this point of view:
  - What are the strengths for your product/service commercialisation? What are the opportunities for your product/service commercialisation? Etc.;
  - Distinguish between internal factors (that come from your company, your products, your know-how etc.) and external factors (that come from your environment, competitors, laws & regulation, market trends etc.).

To work out if something is an internal or external factor, ask yourself if it would exist even if your business didn't.

- Rely on facts, not intuitions;
- Provide figures each time it is possible;
- Prioritise.

Remain synthetic in the matrix and bring explanations below it if necessary (An external reviewer should be able to understand the foundation of your statements).

For more information on how to perform a SWOT analysis, please look at: https://www.mindtools.com/pages/article/newTMC_05.htm

Please use this template to fill in the SWOT analysis for each Mine.io innovative technology.

	Name of service/exploitable asset [XXXX]	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGTHS** *What do you do well?* *What unique resources can you draw on?* *What do others see as your strengths?*	**WEAKNESSES** *What could you improve?* *Where do you have fewer resources than others?* *What are others likely to see as a weakness?*

EXTERNAL FACTORS	**OPPORTUNITIES** **What opportunities are open to you?** **What trends could you take advantage of?** **How can you turn your strengths into opportunities?**	**THREATS** **What threats could harm you?** **What is your competition doing?** **What threats do your weaknesses expose you to?**

	Name of service/exploitable asset [XXXX]	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGTHS**	**WEAKNESSES**
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**

2. BENEFITS TO THE ECONOMY

Please provide us with information on what benefits to the economy your innovation/technology brings about [100 words, in paragraphs]

You can focus on questions such as:

Why investing in such technologies will benefit the economy?
Who will gain from utilizing this technology? How will this benefit manifest?
How will these technologies bring about substantial – beneficial changes to their respective markets/industries?

3. Policy Plans & Regulatory Framework

In this Section, we ask you to provide information on any applicable laws that govern your technology in question. Laws governing the technology could be focused on matters such as: (i) technical specifications, (ii) limitations on utilisation and use of the technology, (iii) registration and/or licensing required for the technology, etc.

We are focused on 2 legal frameworks, namely:

1. *National/EU policy plans supporting/promoting utilisation of such technologies*
    - *EU regulations/directives:*
    - *National law different from EU law? If yes, how?*
1. *Third countries/beyond Europe:*
    - *USA*
    - *Australia*
    - *Other?*

Please provide the following information for each legal framework:

[100-500 words in each legal framework section, in paragraphs, with different subsections for Points 1 and 2 as above]

- *Name of applicable law*
- *Brief description of law*
- *Impact of law on Mine.io technology*
- *Web link access to law*

[type here]

4. TECHNOLOGICAL TRENDS

Please provide the information with references (web links to publications/articles). [100-500 words, in paragraphs]

Why is there a move towards utilisation of this technology?
Which industries would benefit the most from the use of this technology?
What is the current market growth for this technology?
What are the current uses and what could be future uses of the technology?

Have major economic/financial/industrial and/or geo-political actors taken any steps towards utilising/developing/regulating the technology?

5. Key Innovative Technology - Comparison Criteria

It is essential to properly identify your solution comparison criteria, as they will allow you to benchmark your solution against competing ones, to highlight your competitive advantages and to help you define your unique value proposition to the prospective owners/operators.

How to identify your solution comparison criteria:

- *Your solution comparison criteria must be as common as possible to all competing solutions.*
- *They should reflect the main technical and/or functional characteristics of the solution and the main investment and exploitation issues at stake.*
- *They should be customer-oriented i.e. they should be defined regarding customers' use cases, their needs and their constraints (financial, technical, skills related etc.).*
- *They should be adapted to your customers' profiles. If your customers are very technical, you should foster technical criteria. If not, you should foster functional ones.*

The template table provided below will assist you in structuring your comparison criteria. Fill in the relevant fields accordingly.

Lead Partner	**Pilot Technology**	**Technical Criteria**	**Functional Criteria**	**Commercial Criteria**

6. Competitive Landscape

In the Competitive Landscape Section, you are asked to compile a list of relevant competitive technologies.

The first question on competition intensity is aimed at creating a general image of the competition within the industry. It is based upon Michael Porter's "Five Forces" strategy tool.

1. **Competitive Rivalry**
   How many rivals do you have? Who are they, and how does the quality of their products and services compare with yours?
2. **Supplier Power**
   How many potential suppliers do you have? How unique is the product or service that they provide, and how expensive would it be to switch from one supplier to another?
3. **Buyer Power**
   How many buyers are there, and how big are their orders? How much would it cost them to switch from your products and services to those of a rival? Are your buyers strong enough to dictate terms to you?
4. **Threat of Substitution**
   A substitution that is easy and cheap to make can weaken your position and threaten your profitability.
5. **Threat of New Entry**
   How easy is it to get a foothold in your industry or market? How much would it cost, and how tightly is your sector regulated?

For more information on Porter's "Five Forces", please follow this link: https://www.mindtools.com/pages/article/newTMC_08.htm

For each pilot technology, the competitive landscape should be assessed and drafted and 3 relevant competitors should be included, as per the template herein below:

WHAT IS THE COMPETITION INTENSITY?	
1. Competitive Rivalry *2. Supplier Power* *3. Buyer Power* *4. Threat of Substitution* *5. Threat of New Entry*	

COMPETITOR 1:
DOES THIS COMPETITOR HAVE THE SAME SOLUTION AS YOU?
DOES THIS COMPETITOR HAVE THE SAME CUSTOMERS AS YOU?
WHAT ARE THE LIMITATIONS OF THIS COMPANY COMPARED TO YOUR SOLUTION?
DESCRIBE THE PERFORMANCE OF THIS COMPANY COMPARED TO YOUR SOLUTION?

CAN YOU POINT OUT HOW YOU ARE BETTER OR DIFFERENT (E.G. PRICE, PRODUCT SIZE, MARKET EXPERIENCE, INNOVATION & NEW PRODUCT, VALUE, BRANDING)?
COMPETITOR 2 NAME:
DOES THIS COMPETITOR HAVE THE SAME SOLUTION AS YOU?
DOES THIS COMPETITOR HAVE THE SAME CUSTOMERS AS YOU?
WHAT ARE THE LIMITATIONS OF THIS COMPANY COMPARED TO YOUR SOLUTION?

DESCRIBE THE PERFORMANCE OF THIS COMPANY COMPARED TO YOUR SOLUTION?
CAN YOU POINT OUT HOW YOU ARE BETTER OR DIFFERENT (E.G. PRICE, PRODUCT SIZE, MARKET EXPERIENCE, INNOVATION & NEW PRODUCT, VALUE, BRANDING, ETC?
COMPETITOR 3 NAME:
DOES THIS COMPETITOR HAVE THE SAME SOLUTION AS YOU?
DOES THIS COMPETITOR HAVE THE SAME CUSTOMERS AS YOU?

WHAT ARE THE LIMITATIONS OF THIS COMPANY COMPARED TO YOUR SOLUTION? (1000 CHARACTERS):
DESCRIBE THE PERFORMANCE OF THIS COMPANY COMPARED TO YOUR SOLUTION?
CAN YOU POINT OUT HOW YOU ARE BETTER OR DIFFERENT (E.G. PRICE, PRODUCT SIZE, MARKET EXPERIENCE, INNOVATION & NEW PRODUCT, VALUE, BRANDING?