



MINE.IO

A Holistic Digital Mine 4.0 Ecosystem



**Politecnico
di Torino**

Assessing the Social Sustainability of Digital Transformation in Mining

Isabella Bianco



**Co-funded by
the European Union**

MINE.IO Final Event Workshop | May 7th, 2026 | Mine.io has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101091885.

WHY IT MATTERS?

Mines are more and more digitalized and automated

Increased efficiency

Extraction from inaccessible mines

Valorisation of waste

...What about **PEOPLE** during this transition?

OUR CHALLENGE: EVALUATE THE SOCIAL ASPECTS OF THE TRANSITION

Workers



Local community

Society



Job losses?

Change of competences?

Social acceptability?

Enhanced availability of raw materials?

OUR CHALLENGE: EVALUATE THE SOCIAL ASPECTS OF THE TRANSITION

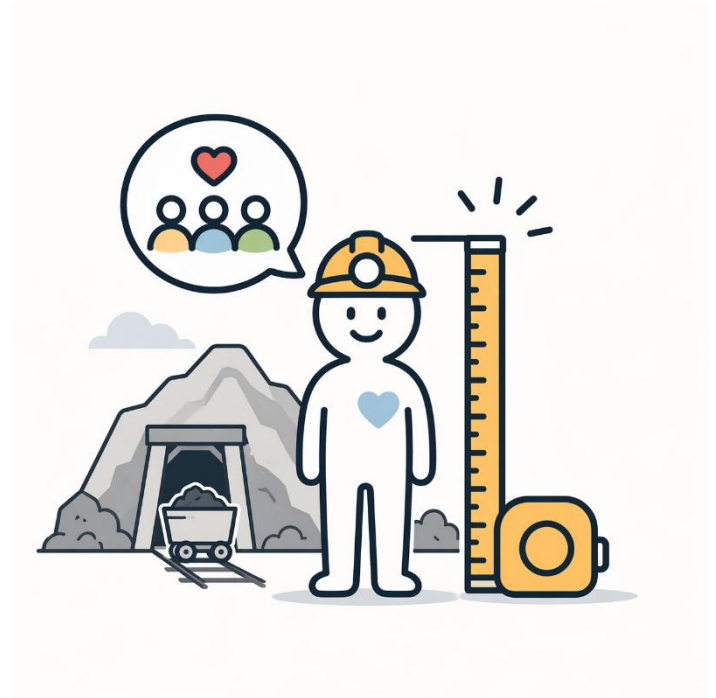
We measure environmental impacts...

We measure costs...

We measure efficiency...

**But how can we measure
social risks and benefits?**

**→ It doesn't exist a simple method to evaluate
and compare social aspects!**



**We need a structured way to assess social impacts
within a mining transformation context**

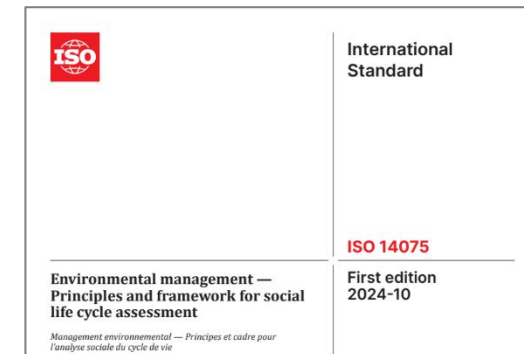
OUR CONTRIBUTION: A FRAMEWORK TO EVALUATE SOCIAL ASPECTS

SOCIAL LIFE CYCLE ASSESSMENT



Good starting points:

- **General** on S-LCA: Guidelines and Standards



- **Specific** to mining context and/or new technology introduction

Horizon 2020 projects:

 ORIENTING



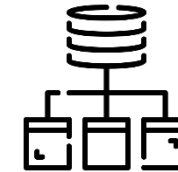
OUR CONTRIBUTION: A FRAMEWORK TO EVALUATE SOCIAL ASPECTS

*Mine.IO
framework
to assess
social impacts
in the mining
context*

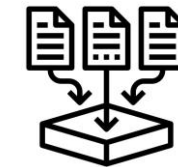
PHASE 1 – MAPPING



PHASE 2 – FRAMEWORK DEFINITION (Goal and Scope)



PHASE 3 – DATA COLLECTION (Inventory)



**PHASE 4 – SOCIAL IMPACTS EVALUATION (LCIA,
Interpretation)**



OUR CONTRIBUTION: A FRAMEWORK TO EVALUATE SOCIAL ASPECTS

PHASE 1 – MAPPING



Literature

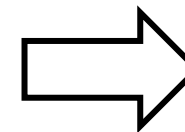


Database



Expert consultation

Which social aspects matter?



Identification of
key potential
social risks and
benefits

related to the
mining context and
new technologies

PHASE 1 – MAPPING

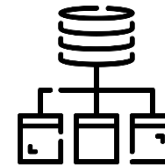
PHASE 2 – FRAMEWORK DEFINITION (Goal and Scope)

PHASE 3 – DATA COLLECTION (Inventory)

PHASE 4 – SOCIAL IMPACTS EVALUATION
(LCIA, Interpretation)

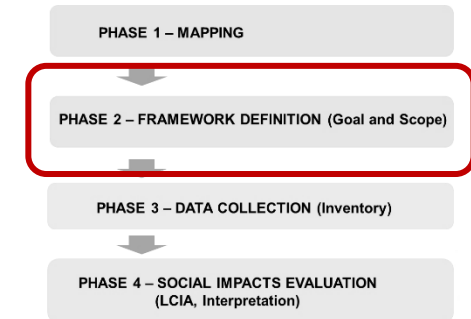
OUR CONTRIBUTION: A FRAMEWORK TO EVALUATE SOCIAL ASPECTS

PHASE 2 – FRAMEWORK DEFINITION (Goal and Scope)



How do we measure social aspects?

- Definition of **CURRENT** vs **FUTURE** scenarios
- **System boundaries** → which phases are included in the assessment



➤ Stakeholders and social aspects

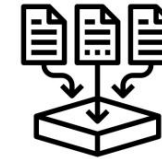


- Development of a **questionnaire** for data collection
- Definition of the **Reference Scale**



OUR CONTRIBUTION: A FRAMEWORK TO EVALUATE SOCIAL ASPECTS

PHASE 3 – DATA COLLECTION (Inventory)



Stakeholders interviews → Questionnaires

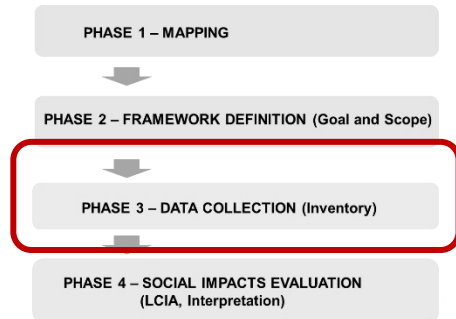
LOCAL COMMUNITY											
Community engagement	Init of measure	SCENARIO 1									
		LOCAL RESIDENT T 1	LOCAL RESIDENT T 2	LOCAL RESIDENT T 3	HUMAN RESOURCE REPRESENTATIVE	COMPANY DIRECTOR	LOCAL BUSINESS OWNER 1	LOCAL BUSINESS OWNER 2	LOCAL BUSINESS OWNER 3	LOCAL NGO REPRESENTATIVE 1	MUNICIPAL OFFICER 1
Have you ever received complaints about work-related issues?	Yes/No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Is there a mechanism or process for dialogue with the community, including to address any complaints? what kind?	Yes/No	No	No	No	No	No	No	No	No	No	No
Are events organised by the local community supported? In what way?	Yes/No	No	No	No	No	No	No	No	No	No	No
Are meetings/workshops with the community or community engagement action/policies organised?	Yes/No	No	No	No	No	No	No	No	No	No	No
Are there any activities or initiatives for the community? what way?	Yes/No	No	No	No	No	No	No	No	No	No	No
Are the activities carried out accepted by the local community or have there been complaints?	Yes/No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Are the activities carried out considered transparent and compliant with local laws?	Yes/No	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Have any awards or recognition been received for social and ethical behaviour towards local communities?	Yes/No	I don't know	2	I don't know	2	2	2	2	2	2	2
Is there a policy for liaising with local communities? Describe	Yes/No	No	No	No	No	No	No	No	No	No	No
Is there a policy for protecting land rights? Describe	Yes/No	No	No	No	No	No	No	No	No	No	No
Is there a sustainable community development plan to	Yes/No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Have there been any social tensions or conflicts due to the impact of mining activities on natural resources, land and	Yes/No	I don't know	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Are meetings organised with community stakeholders?	Yes/No	No	No	No	No	No	No	No	No	No	No
Organisational support (volunteering or working hours) is offered to community initiatives	Yes/No	No	No	No	No	No	No	No	No	No	No
Does a responsible marketing policy exist?	Yes/No	No	No	No	No	No	No	No	No	No	No
Is the implementation of responsible marketing verified?	Yes/No	No	No	No	No	No	No	No	No	No	No

Quantitative and qualitative
data on social aspects

Company data

Existing database → mainly for upstream processes

COMBINATION OF
REAL-WORD DATA
AND EXISTING
DATASETS



OUR CONTRIBUTION: A FRAMEWORK TO EVALUATE SOCIAL ASPECTS

PHASE 4 – SOCIAL IMPACTS EVALUATION (LCIA, Interpretation)



*Evaluation of social
risks and benefits*



Application of the reference scale

Each data from questionnaires is
translated into a score using the
Reference Scale



Aggregation of results by social aspect

Each social aspect is the combination
of multiple questions and indicators.



SYNTHESISE COMPLEX INFORMATION

From multiple indicators

SYNTHESIS AND EVALUATION



EVALUATE IMPACTS

For each social aspect and
each stakeholder group



COMPARE DIFFERENT SCENARIOS

e.g., current vs future scenarios



ASSESS RISKS AND BENEFITS

Across different stakeholders

PHASE 1 – MAPPING



PHASE 2 – FRAMEWORK DEFINITION (Goal and Scope)



PHASE 3 – DATA COLLECTION (Inventory)



PHASE 4 – SOCIAL IMPACTS EVALUATION
(LCIA, Interpretation)

APPLICATION OF THE FRAMEWORK

CURRENT SCENARIO 1

ANCIENT MINE WITHOUT USE
OF 4.0 TECHNOLOGIES



FUTURE SCENARIO 2

ANCIENT MINE WITH USE OF
4.0 TECHNOLOGIES



SCENARIO 3

POST-MINING MANAGEMENT
WITHOUT USE OF 4.0
TECHNOLOGIES



SCENARIO 4

POST-MINING MANAGEMENT
WITH USE OF 4.0
TECHNOLOGIES



From theory to practice

LAVRION PILOT SITE (GREECE)



- Historical mining site with environmental legacy
- Transition from mining to remediation

Example of results:

WORKERS - General	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
Health and safety	-1	0	-1	0
Salaries	0	1	0	1
Social benefits	0	0	0	0
Working conditions	0  	1	0  	1
Discrimination	-1	0	-1	0
Training and education	0	1	0	1
Freedom of association and collective bargaining	0	0	0	0
Job satisfaction and involvement	0	1	0	1

red flag → presence of one or more negative scores

green flag → presence of one or more positive scores

APPLICATION OF THE FRAMEWORK – LESSONS LEARNED



- The method **can be applied** to evaluate social aspects in mining contexts where new technologies are introduced



- The evaluation requires **expert judgement**



- The process is **not** fully **digitalisable**



IMPACT OF S-LCA IN MINING CONTEXT

Why is it important?

- Mining is changing, and **people** must be part of the equation!
- Social assessment helps identify **social risks** early ➤ chance to prevent or reduce them
- Understand **who** is affected and **how**



CONCLUSIONS

Digital transformation is reshaping mining systems, with implications that go **beyond technical performance**.

The **assessment** of potential **social impacts** is key to **understanding** these **implications** and enabling more responsible decision-making.



THANK YOU FOR YOUR ATTENTION!

Gian Andrea Blengini

Isabella Bianco

Giulia Grisolia

Elisa Accorsi

Marzia Traverso (Circular s.r.l.)

Cinzia Capitano (Circular s.r.l.)

Maria Concetta Pedalà (Circular s.r.l.)



**Co-funded by
the European Union**