



**INTERMIN**

**ROADMAP ON SKILLS PROVISIONING FOR**  
**THE RAW MATERIALS SECTOR**

Deliverable 2.3



Horizon 2020

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## Executive Summary

The Roadmap on skills provisioning for the raw materials sector (Deliverable 2.3) of INTERMIN project finalizes the Work Package 2 effort, encapsulating the assessments on employers' needs and related skill gaps identified as well as the projection over time of relevant areas such as market, technology and societal developments. These represent the layers of assessment of the roadmap together with training and skills needed in face of expected development. A series of pertinent indicators were defined in order to support and to serve as signposts for monitoring emerging relevant changes.

First part of the deliverable briefly introduces the layers of assessment, followed by a list of relevant indicators. These are sub-products of the two previous deliverables (2.1 and 2.2) and their rationale can be more exhaustively reviewed in those publications. Finally, Annex A of this document contains a visual depiction of the roadmap on skills provisioning for the raw materials sector.

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## 1. INTRODUCTION

The H2020-Project INTERMIN has started in February 2018 and will last a total of 36 months. Its goal is to create a feasible, long-lasting international network of technical and vocational training centres for mineral raw materials' professionals. Specific objectives of the project are to develop common metrics and reference points for quality assurance and recognition of training and to create a comprehensive competency model for employment across the primary and secondary raw materials sector. INTERMIN activities include:

- a) To develop an international qualification framework for technical and vocational training programs on mineral raw materials' topics, based on present and future requirements by employers.
- b) To foster joint international training programs by a merger of competences and scope of existing training programmes.
- c) To optimise future interaction and collaboration in Europe and internationally.

The project activities require contact with people as well the collection, analysis, treatment and storage of primary data (data collected by the Consortium involved in INTERMIN) and secondary data (data collected by others and published or publicly available). INTERMIN also includes the development of a repository, which consists of a database of documents used and generated by the project.

The 'Raw Materials sector skills, gaps and needs' work package will look into skills that employers are looking for and are likely to be in demand in the future. Gaps will be identified in professional education and training against market demands assessed through three different timeframes and corresponding methods:

- Short-term (Horizon Europe): Desk research and interviews;
- Medium-term (2030): Focus Group;
- Long-term (2050): Delphi survey.

The results will be compared with Work Package 1 'Scoping & Mapping of educational-research programs' to build an integrated competency model for the raw materials sector. This will include the development of prospective scenarios and a roadmap of implementation.

The roadmap will be divided as immediate, medium, long-term corresponding to the three timeframes investigated, as well as four different layers of assessment: market, technology, societal needs and training & skills. A visual depiction of the roadmap is provided in Annex A together with a list of pertinent indicators for monitoring the performance of the sector and consequential changes.

## 2. CONTENT AND SCOPE

This document synthesizes the assessments carried out in Work Package 2 (Deliverables 2.1 and 2.2) and establishes a time-based depiction of skills provisioning for the raw materials sector as well as pertinent indicators to be monitored. So far, Work Package 2 was able to identify i) where we are now and ii) where we are going. This deliverable aims at supporting the exploration of i) what are the ways of getting there and ii) what should we do. Annex A depicts a time-based visual roadmap for skills provisioning in the raw materials sector.

### 2.1 Definition of roadmapping layers

Roadmapping has become one of the most frequently used tools for bridging the future with the present – it is used to guide decisions on research, development and innovation by providing information on its components as well as providing strategy recommendations (Miles et al. 2016). The Roadmap is developed through different layers: the pertinent areas of change for raw materials skills provisioning over time. For the Work Package 2 “Raw Materials sector skills, gaps and emerging knowledge needs”, the layers of assessment were defined based on the relevant factors driving current and future skills and competencies needed in the sector. As such, the layers covered in the roadmap are:

1. **Market:** where the focus is to capture employers’ needs and market trends likely to shape the future of companies in the sector;
2. **Technological evolution:** skills and competencies required are largely dependent on the evolution of the technologies developed and adopted over time in the sector and society at large.
3. **Societal expectations:** such aspect ultimately dictates how professionals and companies should interact with society at large as well as meeting their needs and expectations in the present and future.
4. **Training & Skills:** Corresponding needs in skills and training in raw materials

#### 2.1.1 Market (Employers)

Taking a broad view on the raw materials sector, there is a wide variety of employers’ profiles that directly or indirectly demand raw materials professionals and specific skills and competencies. Namely:

- Raw materials producers (primary and secondary);
- Mineral exploration companies;
- METS (Mining Equipment, Technology and Service providers);
- Governmental agencies and geological surveys;
- Universities, Research & Development centres;
- Financial markets and private equity firms; among other.



Raw materials markets are typically marked by a cyclicity of the raw materials prices, stemming from demand and supply dynamics, which in turn also affects workforce needs. Such dynamic can create shortage in available skilled professionals as well as age gaps between generations of professionals. This can become especially critical at the local/regional level and has been reported as one of the main barriers for the adoption of new technologies.

Among the identified trends, companies are expected to increasingly compete with other sectors to attract talents, especially in advanced IT jobs. Also, organisations tend to become more diverse, professionals with different backgrounds working together, but also sharing an increasingly ‘fluid’ workplace: performing (part of the) tasks virtually/remotely.

A particular issue is that of size of companies and their ability to offer in-house training centres, where small companies tend to typically rely on external sources of training at best.

### **2.1.2 Technological Evolution**

As shown in previous reports (Deliverable 2.1), evolving technologies will require professionals to develop new skills. Current trends point to an increase in demand for advanced IT skills and complex problem-solving abilities and a decrease in more manual and repetitive tasks. The convergence of different (digital) technologies, artificial intelligence and automation is driving the workforce towards higher cognitive tasks.

### **2.1.3 Societal expectations**

The raw materials sector and current operations are expected to improve – and even exceed – environmental expectations, strengthening community relationship and social responsibility. Companies will need to become more transparent. Also, introduction of new technologies and changes in operating models must be aligned with the social dimension and public perceptions.

### **2.1.4 Training & Skills**

New disciplines will be created, while others will be brought closer to raw materials applications in face of the sectoral evolution.

## **2.2 Roadmap indicators – measuring performance and outcomes to short, medium and longer-timeframes**

Pertinent indicators are important to keep track of possible changes and serve as a signpost for early warning on potential disruptions in the sector. In this roadmap, as skills and competencies are subject to change, the definition of indicators to monitor performance of the sector can help the continuous improvement of training agendas and curricula adjustments for training centres, universities and professionals seeking to be more prepared for expected changes.

In Deliverable 2.2, the Work Package assessed pertinent indicators for each chosen driver in the development of the scenarios (summarised in Table 1).

Table 1 - Pertinent raw materials indicators summary (based on Deliverable 2.2)

<b>Drivers</b>	<b>Pertinent indicators</b>
Geopolitics	<ul style="list-style-type: none"> <li>• Scarcity of resources and conflicts</li> <li>• Governance Indicators</li> <li>• Criticality assessments</li> <li>• Trade disruptions</li> </ul>
Regulation/ Legislation	<ul style="list-style-type: none"> <li>• Policy Perception Index</li> <li>• Directives</li> </ul>
Social Acceptability	<ul style="list-style-type: none"> <li>• Accidents and Incidents</li> <li>• Frequency of project's stalled by social issues</li> </ul>
Recycling and Circular Economy	<ul style="list-style-type: none"> <li>• Raw Materials consumption</li> <li>• Recycling rates, efficiencies – vs. primary production prices</li> <li>• Levels of complexity in end products</li> </ul>
Mining and processing – actors and activities	<ul style="list-style-type: none"> <li>• Supply concentration (HHI<sup>1</sup>)</li> <li>• Ore grades</li> <li>• Level of emissions (GHG)</li> <li>• Energy and water intensity</li> </ul>
Prices and production costs of raw materials	<ul style="list-style-type: none"> <li>• Costs of energy and EROIE<sup>2</sup></li> <li>• Share of by-product production in the profitability of operations</li> </ul>
Technologies to find, access and process raw materials	<ul style="list-style-type: none"> <li>• Level and speed of adoption of new technologies</li> <li>• Annual R&amp;D Investment</li> <li>• Patent applications in the sector</li> </ul>
Channels of education	<ul style="list-style-type: none"> <li>• Levels of digital learning – multi-modal offering suites</li> <li>• Level of investments in digital training</li> </ul>

For the purpose of INTERMIN Roadmap, this report suggests the following indicators:

- **Number of advanced students in raw materials dedicated programmes**
- **'Raw materials skills intelligence'<sup>3</sup>**
- **Levels of change by skills categories**
- **Share of machine-based/human-machine interface tasks**
- **Retraining and upskilling**

<sup>1</sup> Herfindahl–Hirschman Index ([https://en.wikipedia.org/wiki/Herfindahl%E2%80%93Hirschman\\_Index](https://en.wikipedia.org/wiki/Herfindahl%E2%80%93Hirschman_Index))

<sup>2</sup> Energy returned on energy invested (see Deliverable 2.2)

<sup>3</sup> Data analysis of professional network big data (e.g. LinkedIn).

- Retention and attraction strategies
- Cross-sectoral mobility
- Levels of automation in operations
- Levels of 'digitalisation' in operations
- Social acceptance of raw materials production
- Emergence of new business models
- International knowledge transfer programmes
- Availability and coverage of online training courses in raw materials
- Levels of (re-)training in raw materials companies
- Share of 'data wrangling' work hours<sup>4</sup>

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<sup>4</sup> How much time a professional spends in non-specialised activities

### 3. CONCLUSIONS

Successful skills provisioning for the raw materials sector depends on a complex web of factors that first must be acknowledge together with the uncertainties associated with their future development. It is understood that this implies many dimensions of analysis, such as:

- Geography: socio-economic and political profile of the region or country as well as its mineral endowment;
- Types of raw materials: base metals, industrial minerals, precious metals and building materials have inherent different market structures and characteristics;
- Scale of operation: social and environmental impacts as well as types of technologies applied can vary widely, from small-scale, quarrying operations, to integrated multi-mine complexes of raw materials production.
- Value chain stage: as production of raw materials have a well-known life cycle, each stage can pose its own particularities in terms of skills and competences needed.

This roadmap therefore sought to capture the main components of different layers of assessment projected over time as well as skills and competencies that will be important in these developments. Market, Technology and societal developments are expected to be behind the main drivers shaping the future of the sector.

Further scenario analyses (Deliverable 2.2) can be undertaken to explore these issues in more detail together with indicators, allowing for better anticipatory capacities as well as serving as signposts for emerging changes.

## 4. BIBLIOGRAPHY

Correia, V., Sánchez, A., Fernandez, I. 2019. International Qualification Framework for the Raw Materials Sector. Deliverable 3.1, H2020 INTERMIN Project, Grant Agreement: 776642.

Martins, M. K., Bodo, B. 2019. Report on Skills Gaps. Deliverable 2.1, H2020 INTERMIN Project, Grant Agreement: 776642.

Martins, M. K., Bodo, B. 2019. Integrated competency model for employment across the raw materials sector. Deliverable 2.2, H2020 INTERMIN Project, Grant Agreement: 776642.

Miles, I., Saritas, O., Sokolov, A. (2016) Foresight for Science, Technology and Innovation, Science, Technology and Innovation Studies, DOI 10.1007/978-3-319-32574-3\_9

# ANNEX A

## Visual roadmap illustration



