MOBI-US, an EIT RawMaterials project: Deliverable D1.5 – Chapter in the structured mobility guideline about the latest results on European qualification framework, skill and competence catalogue for the raw materials sector

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1. Executive summary

The “Guideline document compilation” work package aims at providing a guideline material for the networking universities in order to help the efficient partner finding and the preparation of documentation background for linked programmes. This report contributes to this goal with an analysis on the European qualification framework used by academia, as well as with information on a skill and competences catalogue for the raw materials sector, which are supported by analysis on the gaps and needs of the Raw Materials industry that are going to shape the education and training of students and professionals in the near future, to which MOBI-US network will be part of.

This task takes its roots in the INTERMIN project, where the groundwork was already developed. An analysis on the work done during this project and that is of relevance to MOBI-US is done, and conclusions for the MOBI-US implementation are drawn, which will lead to the chapter to be included in D1.6. MOBI-US is suggested to use the following topics previously studied in INTERMIN (knowledge transfer):

a) The skills catalogue developed for the raw materials sector
b) Report on skill gaps in the sector
c) Integrated competency model for employment across the raw materials sector, and
d) International qualification framework for the raw materials sector

Alongside the analysis and identification of items from INTERMIN, this report contains a set of recommendations and conclusions for the proper knowledge transfer from INTERMIN and the implementation of important items in the MOBI-US project activities.

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2. Introduction

The main goal of this chapter, and WP1 as a whole, is to support the networking partners of MOBI-US with a set of guidelines to help them prepare the master courses and establish fruitful mobility programmes while ensuring a continuation of implementation after the project's aftermath. In the specificity of this report, the aim is to provide insights on the skills needs of industry and make the bridge between education and industry in the raw materials sector. This can be achieved by introducing efficient teaching solutions in the master programmes while at the same time support the mobility schemes with partner searching and refinement of the mobility window courses offered in the home programmes of ESEE universities. The guidelines of this deliverable are, therefore, essential for a good implementation of MOBI-US and shall be aligned with the guidelines provided by the remaining WP1 deliverables. The focus given to mining, minerals, recycling and materials engineering issues are incorporated in the developed work as they are transversal to the raw materials education courses offered.

This deliverable (also called chapter as per Project Agreement) reflects on the findings of the Horizon 2020 project INTERMIN (www.interminproject.org, Grant Agreement No. 776642) on the skills, gaps and related issues for the raw materials sector. It is based on reports from Work Packages 1 (Worldwide mapping of educational-research programs), 2 (Raw materials sector skills, gaps and needs) and 3 (Towards enhanced training programs). The following INTERMIN deliverables were screened:

- D1.1 – Skills catalogue for the raw materials sector (Regueiro and Jordá, 2018)
- D2.1 – Report on skills gaps (Konrat Martins and Bodo, 2019)
- D2.2 - integrated competency model for employment across the raw materials sector (Konrat Martins et al., 2019)
- D2.3 - Roadmap on skills provisioning for the raw materials sector (Konrat Martins and Bodo, 2019)
- D3.1 - international qualification framework for the raw materials sector (Correia et al, 2019)

The above-mentioned work packages focus on different, but altogether relevant aspects for the raw materials sector: current and future skills, competence gaps, qualification frameworks, raw materials education and training, knowledge needs, employment, among others. The outcomes

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are fairly important to the education system, especially adequate for higher education levels (such as masters programmes), as well as to the industry. In a changing field, where future employees (current and future students) will need to acquire and adapt skills and competences, the education system needs to adjust to the future requirements of the industry. When the needs of MOBI-US are put into scope, one can agree that the INTERMIN project has a good source of groundwork that can be used for the benefit of this project, leveraging the knowledge transfer between European projects. Competence development assumes particular relevance in the scope of the project.

Based on current and future skills and gaps in competences for the raw materials sector industries, a set of level descriptors for the raw materials education system was suggested. This is based on three areas of high interest: 1) mineral exploration, 2) mineral extraction and processing and 3) material engineering and recycling. Despite having level descriptors for different levels, in this document only the ones that important for the MOBI-US project are transcribed, i.e., the ones that are translated to the master's Programmes levels (level 7 in EQF system).

Due to the specificity of the raw materials sector, INTERMIN suggests the introduction of a new classification framework (substituting the actual EQF in place in Europe). This framework, the "sectoral qualifications framework for the raw materials sector" (SQF-RM) is designed to work worldwide, which strengthens adaptability and mobility of education programmes, such as the aim of MOBI-US. This framework has its roots in the EQF.

Figure 1 displays what are the main inputs used from INTERMIN's results and outcomes, how they, when analysed, contribute to the development of this deliverable, which, in turn, contributes to the creation of D1.6, the Guideline Document for the network partners of MOBI-US.

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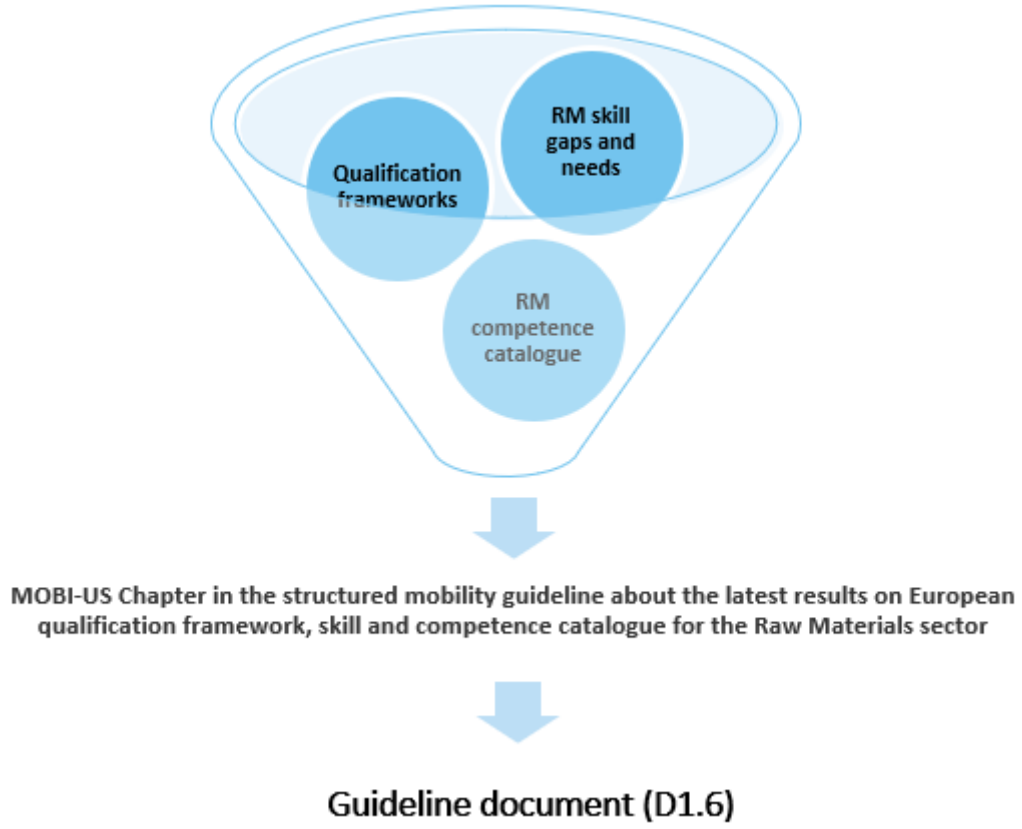

Figure 1: Inputs for Deliverable 1.5 and relation to Deliverable 1.6

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3. The INTERMIN project outcomes and knowledge transfer to MOBI-US

The INTERMIN project - International Network of Raw Materials Training Centres – is aiming at creating and fostering a network of training centres for the raw materials sector, that together with the higher education systems can help the future workforce (current and future students) to be prepared for the changing raw materials sectors' fields. Industry is already lacking some skills and competences in its employees and, therefore, is calling and supporting changes in the education system to fit its needs. Industry is, in fact, a crucial driver for the education system and for MOBI-US as it is industry that ultimately drives what skills and competences are taught and given to students. MOBI-US acknowledges this fact and will involve the ESEE raw materials industry in the project activities.

As INTERMIN studied and analysed, many of the topics that are relevant for the implementation of MOBI-US, some of its most relevant results and outcomes are suggested to be applied in this project, and they are quite transferable and adaptable to the mobility programs as they try to cover important needs in the education systems of universities in the ESEE region. The most relevant outcomes transferable to MOBI-US lie in:

a) The skills catalogue developed for the raw materials sector (D1.1)
b) Report on skill gaps in the sector (D2.1)
c) Integrated competency model for employment across the raw materials sector (D2.2), and
d) International qualification framework for the raw materials sector (D3.1)

Each of these deliverables/main topics result in the subsequent four sub-chapters of this deliverable. The main outcomes of this chapter and sub-chapters can be seen as recommendations fit within Chapter 4, which will lead to the final chapter to be included in D1.6.

3.1. The skills catalogue developed for the raw materials sector

INTERMIN developed a skills catalogue for the raw materials sector, which includes an extensive list of skills, competences and knowledge currently offered by education and training centres in many areas of geosciences at international level (although with focus on Europe). More than 180 institutions and more than 370 programmes related to raw materials are part of such list. As an example, all the networking partners and masters programmes involved in MOBI-US are part of

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this list and their skills and competences offered were analysed. These are available on a free online platform (https://interminproject.org/preliminary-survey-results/) resulting from an extensive survey.

The previously mentioned tool offers the possibility to study the offering of respective raw materials skills and training in different countries, universities, regions, and languages. Due to its extensiveness, this is a tool that can be used by the MOBI-US networking partners to assess possible universities and/or training centres of the ESEE region as collaborators for the implementation and extension of the project's mobility programme. The main outcome of this work is contained in INTERMIN's D1.1 and in the referred public online database. The importance for MOBI-US lies in the list of skills offered by the ESEE universities and training centres. The database offers the perfect pool of potential candidates for the extension and integration of the mobility programs.

The following list of items contains the key elements/knowledge bits that shall be transferred from INTERMIN and applied in MOBI-US, on the skills catalogue (based on INTERMIN's deliverable 1.1). The implementation of these items shall help the success of MOBI-US in making a fruitful mobility program:

1) Streamlining vocabulary (definitions) and establishing a MOBI-US threshold for common language;
2) Scope: ensuring gender balance and comprehensive scope at the masters programmes levels across ESEE current and future networking partners;
3) Assessing skill shortages and the kind of professionals (I or T) the raw materials industry is looking for;
4) New skills and sustainability of the skills catalogue from INTERMIN to implement to MOBI-US, such as
    a. Environmental concepts
    b. Computing
    c. Advance in robotics and automation
    d. Social aspect in mining and industry

MOBI-US vocabulary

Intervening in both fields of raw materials industry and education, the MOBI-US project deals with a number of vocabulary items that will be used transversally to most project activities and across

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different partners. In order to maintain a common approach, the following vocabulary is suggested to be streamlined:

- Skills;
- Competences;
- Knowledge;
- Gaps;
- Capacities;
- Subject;
- Course;
- Programmes;
- Qualifications;
- Learning outcomes;
- Mobility (pathways).

Note that items in red (skills and competences) are more likely to be subjected to see their meaning changed in each university/networking partner due to their specificity. Therefore, it is crucial for MOBI-US to ensure a minimal threshold for any definition applied. This threshold will not only ensure clarity for students and course/programme coordinators but will also ensure that any student can be certain that the skills and competences he or she will acquire during his or her exchange period can be accepted as valid ECTs. If definitions of any given item of the aforementioned list or any definition used for MOBI-US meets discrepancies in any of the partners universities, uniformization of the vocabulary should be implemented, as shown in Figure 2:

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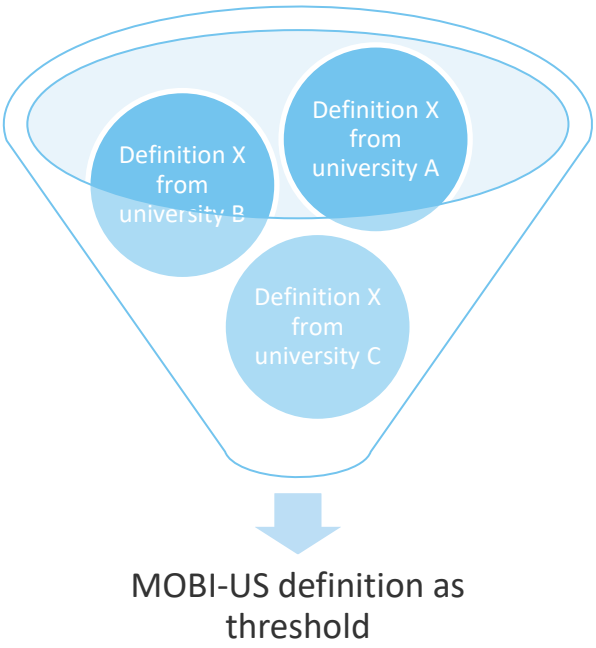

Figure 2: MOBI-US needs to employ a standard, common definition within its structured mobility programs

Scope

MOBI-US shall assess the need of the industries to fit the most relevant education and training to the students during their exchange, covering possible gaps. This assessment shall be continuous as the needs and demands of the industries are in constant evolution, therefore education should follow this evolution to better prepare the future workforce.

MOBI-US may also see fit to expand the scope of profiles in its exchange programs to encompass other geosciences disciplines. In addition, gender equality is an important social issue nowadays. The Von Der Leyen Commission placed gender equality on top of the political agenda, notably by establishing gender balance among commissioners. Considering this, MOBI-US shall promote gender equality among its exchange students. This could be achieved by taking inspiration from the ENGIE project (https://www.engieproject.eu/), whose aim is to turn the interest of females to study geosciences and geo-engineering, and thus to improve the gender balance in the fields of these courses. The project will develop an awareness-raising strategy and create a stakeholder collaboration network for the implementation of a set of actions in more than 20 EU countries, including ones in the ESEE region. The project envisions attracting more young women to the raw materials related scientific and engineering sectors.

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MOBI-US program shall promise to be an equal opportunity program. Said mandate could take the following structure:

"MOBI-US does not and shall not discriminate on the basis of race, colour, religion, gender, gender expression, age, national origin, disability, marital status, sexual orientation, or military status, in any activities or operations. These activities include, but are not limited to exchange programs, counselling; selection of students and provision of services. We are committed to provide an inclusive and welcoming environment for all members of the projects, partners and exchange students.

[signature of the project coordinator]
[signature of representant of University A]
[signature of representant of University B]
[signature of representant of University C]
[signature of representant of University D]"

Based on this declaration – or any other of similar nature-, proof of this mandate shall be kept under the form of a spreadsheet proving balance. If this spreadsheet is approved by project partners, it shall be crucial to respect GDPR and students shall be able to give their consent to see their data (but excluding their name and private details) used for a statistical survey. Items covered by this survey may include, but are not limited to:

- Gender (according to the LGBTQIA+ nomenclature and including a "rather not say" option);
- Age (including a "rather not say" option)
- Field of study and degree
- Ethnicity (including a "rather not say" option)
- Religion (including a "rather not say" option)
- Prior experience with Erasmus+ or other exchange programs
- Would you apply for another exchange program?
- How would you rate the MOBI-US project?

A simple survey of this nature could help MOBI-US to better understand and steer the mobility programs in order to achieve a fruitful outcome.

Skill shortages and raw materials professionals

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Skills shortages in any field are linked to foresight and drawing a timeframe in which a specific set of skills will be in demand (Figure 3). In addition, matching demand of skills with its demand. Matching offer and demand not only ensures a proper matchmaking with the industry but also ensures jobs to prospective students and the insurance they will not overflow a low demand sector or let a high demand sector on the side by being misinformed at the start of their studies, during their studies or at graduation.

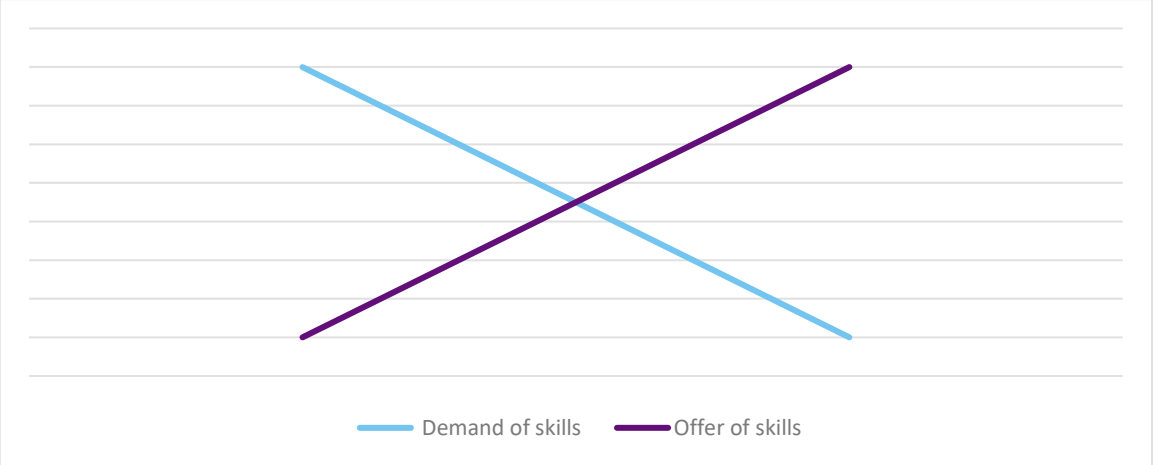

Figure 3: Theoretical model of offer and demand of skills in Raw materials before assessment

Shortage in skills and competences are a common problem of a lot of European industries and so much more in the raw materials sector. This has already been acknowledged as one of the major challenges facing the industry globally as well as in Europe (referenced in the Raw Materials Scoreboards[1] from the EC, for example). The same conclusion can be taken from Ernst & Young's annual reviews of the mining and metal industry business risks (as for example in their 2019 assessment). It their analysis they ranked skills shortages as the main risk faced by the mining industry, which are driven by technological advances, cyclicity and demographics.

Regarding skills shortages, INTERMIN also identified the need of the so-called T-shape professionals (Figure 4; Definition: T-shape professionals are characterized by their deep disciplinary knowledge in at least one substance area and capability across the boundaries between disciplines) in the raw materials sector industries. Therefore, it is advisable for the mobility courses to include skills development that fit into the scope of a T-shaped professional. This kind of professionals is already in high demand for their ability to innovate, build relationships, advance research and strengthen their organization, and many industries are already preferring these types of workers.

[1] https://op.europa.eu/en/publication-detail/-/publication/117c8d9b-e3d3-11e8-b690-01aa75ed71a1

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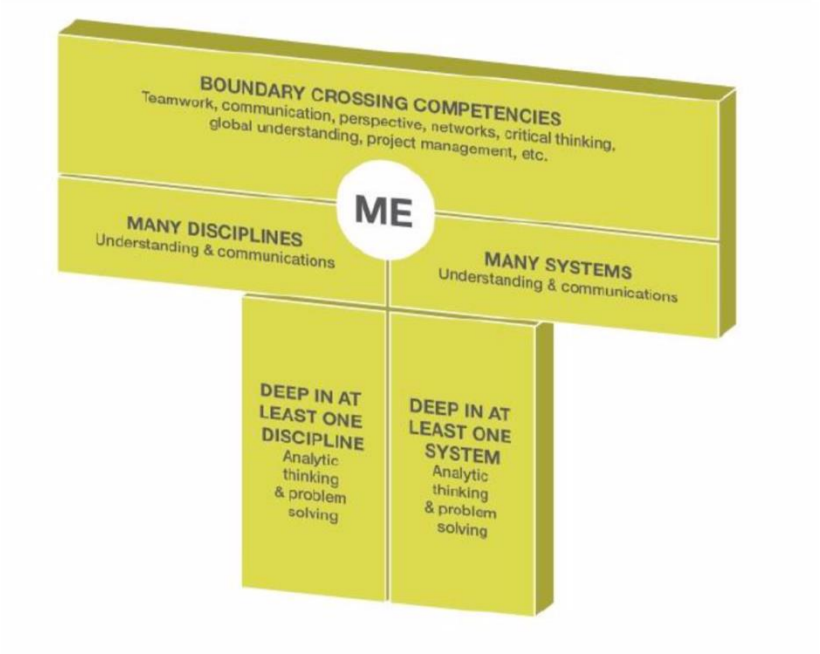

Figure 4: Characteristics of a T-shaped professional (source: www.tsummit.org)

T-shape professionals are becoming common sight in the working environment. INTERMIN concluded that employers are placing increasing importance on skills that go beyond a single discipline. However, there are some barriers for the "shaping" of students:

- Researchers receive strong focus on technical excellence but very little on "soft" skills
- Lack of practical training and cooperation with industry
- Lack of improvement of employability skills in technical universities
- Low number of policies supporting collaboration between universities, research centres and industry.

It is of relevance for MOBI-US to guarantee that the exchange and mobility programs will follow the value of T-shape professionals as they are an attractive and high demand commodity on the job market. The T-shape approach shall improve on some requirements including, but not limited to, new systemic innovations in areas of waste reduction, recycling, material efficiency and residue utilization. It is also necessary that professionals have a deep understanding of the raw materials system and the entire value chain. These requirements are transversally important to academia, industry and research alike. However, most of the education and training offered in the raw materials spectrum focus on only one field.

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New skills and competences for the raw materials sector

Although classically considered as "conservative", the mining industry did develop new skills in the last decade of the 20th century, a trend that is seen nowadays as well. These are skills that relate to the overall of the raw materials value chain. For MOBI-US they are of special importance on three areas: 1) minerals and mining, 2) recycling and 3) materials engineering.

Table 1 discloses the most relevant skills and assess whether or not they are still relevant today.

Table 1: New skills for the raw materials sector and their relevance in 2020

Skill	Current Relevancy
Introduction of the **environmental concepts**. Environmental impact studies and specific regulations for the closure of mines from the 1980's. Initially there was a lot of reluctance and it was difficult to introduce these concepts in the industrial sectors, however the inclusion of environmental aspects in the business plan of a company and as a skill is already a consolidated reality.	**Particularly relevant** in the context of the Green Deal.
Computing, new technologies and the internet. Since the 1990's it is an indispensable skill in technical studies and these are fully consolidated.	**Particularly relevant** with the growing importance of computer engineering.
Advances in robotics and automation. Emerging skill that is usually learned in the workplace.	**Particularly relevant** with the growing importance of computer engineering.
Social aspect in mining and industry, licensing and public awareness. Many mining projects in Europe (in particular) having passed all the technical, legal and environmental filters, are being blocked by social disconformity. It can be said, without a doubt, that the social license to operate (and everything related to NIMBY) is the Achilles heel of the extractive industry in Europe and many countries of the world, thus it has become a very relevant emerging skill.	**Particularly relevant** with the current need for Social License to Operate that mining companies must adhere to

All of the above-mentioned recent skills needed for the raw materials industry have some degree of importance in the current and future panorama for the raw materials sector and should,

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therefore, be fostered in the education and training of raw materials professionals. In the light of the MOBI-US mobility programs.

3.2. Skills and competences gaps in the raw materials sector

To assess the skill and competences gaps in the raw materials sector, the INTERMIN project followed a three steps approach with three different timelines on focus:

- Short-term skills gaps (Horizon Europe; data collected through desk research)
- Medium-term skills gaps (2030; data collected with the help of focus groups sessions)
- Long-term skills gaps (2050; data gathered thanks to a two-stage Delphi survey)

In addition to this methodology, MOBI-US shall implement the results of the INTERMIN survey. The results came out on January 2019; therefore, they are relevant in the MOBI-US context. In addition, using past results can save time and effort, thus increasing the time and money efficiency of the whole project. It is recommended to follow INTERMIN's classification of gaps as coherence between EU-funded projects dealing with similar fields might result in greater coherence and support to raw materials policies at large. Said coherence could prove useful for readers/stakeholders familiar with INTERMIN for them to better understand the goals and benefits of the MOBI-US project.

The following section will detail the list of gaps seen for geoscientific fields for the three time horizons: short, medium and long. They are all of importance for the implementation and sustainability of the MOBI-US project and its mobility programs.

Short-term skills gaps (Horizon Europe panorama)

INTERMIN defines short-term skills gaps as: "Immediate needs in terms of skills and competencies are expected to fit within the present-day trends in the raw materials sector (…).". Given this definition, it is then crucial for MOBI-US to place these skills at the forefront of its programs as these gaps are currently in demand in the raw materials industry and should be solved first. Meeting the demand of skills will not only ensure the relevance and efficiency of MOBI-US but will also enable students to enter the job market with confidence, which will support the ESEE raw materials industries.

The following skill gaps were presented by the INTERMIN project thanks to the results of *WEF (2016) and MGI (2018) reports.* These skills are:

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- Physical and manual skills
- Basic cognitive skills
- Higher cognitive skills
- Social and emotional skills
- Technological skills
- Abilities
    - Cognitive abilities
    - Physical abilities
- Basic Skills
    - Content skills
    - Process skills
- Cross-functional Skills
    - Social skills
    - Systems skills
    - Complex problem-solving skills
    - Resource management skills
    - Technical skills

Such categories are used to identify across different occupations where positive and negative changes are expected to occur and relate to the observed drivers for specific industry, geographies and other factors The research done by MGI (2018) in the Energy and Mining sector shows an expected increase in demand for higher cognitive skills, social, emotional and technological skills expected for the next years. In other words, skills related to quantitative and statistical abilities, critical thinking, complex problem-solving and creativity are expected to increase in demand, while basic cognitive skills such as basic data input and processing are likely to decrease due to the increase in automation. The 'Mining & Metals Industry profile' by WEF (2018) projects on the short-term, based on companies surveyed, a move towards augmented machine-based share of job tasks in relation to humans (10-30% of share of task hours). The survey also projects the emergence of roles such as 'new technology specialists', 'data analysts and scientists', 'big data specialists', 'AI and Machine Learning specialists' and 'systems engineers', among other. On the other hand, roles such as 'plant operators', 'management and organisation analysts' and 'extraction workers' are expected to decline by 2022.

The OECD (2016) also highlights that future of work will be marked by a decrease in routine tasks with growing emphasis on skills that cannot be automated. In that sense, 'soft skills' can gain in prominence, such as the ability to communicate in diverse settings, work in teams, and solve complex problems. This, however, does not preclude a rapid rise in demand for ICT (Information and Communications Technology) specialist skills, which in turn points to an increased potential risk of skills mismatch. Such gap may be more acute in emerging economies (WEF, 2017).

On top of desk research and conclusions of universities, it is important to assess industries' demand to coordinate supply accordingly. Research suggests that industries tend to invest in re-skilling of

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current employees, support mobility and job rotation, increase collaboration, target and attract female and foreign talent, among other. This first point is particularly relevant for MOBI-US as employees are to meet new requirements rather than companies to invest in new hiring (e.g. fresh graduates).

Mining & Metals Industry analysis points out the main strategies raw materials companies need to tap into:

- Retrain and upskill
  - Imperative for companies to compare their current skills base against the skillsets that will be needed in the near future
- New retention and attraction strategies
  - Due to scarcity and high competition for tech-savvy professionals
- Source and integrate talent across networks
  - By attracting talents from other sectors and industries
- Redesign work for technology and learning
  - Identify areas where digital technology can translate into better worker performance
- Create a new social contracts with communities and governments
  - Mitigate new labour dynamics in relation to local, regional and even national communities and governments

In addition, the widespread digitalization of society will push companies to compete to hire the best technician and ICT specialists to remain on top of the competition. Finally, the raw materials sector is set to see a shortage in mentorship positions.

WEF (2018) listed 10 trends shaping overall industry growth:

1. Increasing adoption of new technology
2. Advances in devices bridging the human-machine divide
3. Advances in new energy supplies and technologies
4. Advances in Artificial Intelligence
5. Shifts in national economic growth
6. Expansion of education
7. Expansion of gender parity
8. Increasing availability of big data
9. Shifts in global macroeconomic growth
10. Advances in cloud technology

More recently, a report commissioned by the Minerals Council of Australia (MCA) and Ernst & Young (2019) suggests that technological innovations will impact work in the whole raw materials value chain – from exploration to trading (Table 2):

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Table 2: Short-term skills requirements for the mining value chain

Mining value chain storage	Workforce impact and skills required
Exploration	• Reduction in drilling operators due to automation • Increased demand of analytics and modelling skills • Increasing share of remote work
Mining Operations	• Reduction in drilling operators due to automation • Key skills shift from technical execution to decision support focus • Emerging roles: 'systems engineering' and 'data scientists' • Increasing share of remote work • More complex problem-solving thinking ability to anticipate and plan activities • Managing human-to-machine interfaces • Advanced systems development and integration
Processing	• Increase in advanced analytics and 'big data' applications – i.e. 'data scientists'
Transport	• Upskilling of operators to manage human-to-machine interfaces • Advanced systems development and integration – management of autonomous systems and shipping platforms
Trading	• Shift on the operating model from mining based on volumes to mining based on quality and customer requirement focus.
End-to-end	• Dealing with increased complexity of planning, scheduling and advanced decision-making – complex systems management for end-to-end optimisation • Technical modelling and advanced geological and geo-spatial capabilities.

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Medium-term skills gaps (2030 panorama)

Previsions for short-term skills gaps are likely to remain relevant for medium-term (due to the short timespan between the two considered horizons). Specifically, in-house training of employees is set to become even more common. The T-Shaped professionals mentioned in the previous section are set to become trending too. In addition, reports suggest that the key items relevant for foreseeable future lie in:

1 Moving away from getting "bigger and bigger" or "bigger is better" and economies of scale - in other words, rethinking approaches to develop mineral deposits; focus on small and difficult to access deposits
2 Social issues are becoming the main challenge for the mining industry for the next 10-15 years, and Social License to Operate will assume even more importance.
3 Increase in online courses and training in raw materials – though not every skill/competence may be acquired online.
4 Progression of integrated teams to integrated professions, where skills deployment turns more agile.
5 More companies seeing themselves as 'Raw Materials companies' – in response to ongoing sectoral dialogues and programmes such Horizon 2020 and Horizon Europe.

Long-term skills gaps (2050 panorama)

This list of requirements for young professionals has been obtained thanks to research and a Delphi survey. The following statements are recovered from the INTERMIN Delphi Survey. Only Statements which had a majority of "agrees" will be featured as they are the ones who reached positive consensus among the expert participation. Wherever necessary, comments will support the explanation of the statements.

- While conventional mining will evolve to deeper and larger open-pits and ultra-deep underground operations ('supercaves'), it will co-exist with novel, not yet developed mining methods.
- By 2050, the majority of mine sites will be fully autonomous operations"
    - While most respondents were on the agreement side in the first round, some scepticism was observed regarding the 'fully autonomous' expectation. The consensus was observed strongly with regards to the continuous increase on automation in mine operations, with constraining factors such as time horizon proposed, need for human grade control interaction etc. Second round presented similar views, underlining expectations for fully autonomous systems especially for

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routine processes (trucks, shovels, drilling etc.). Emerging skills gap were repeatedly related to an 'advanced digital literacy' for professionals including programming, mechatronics and AI skills.

- Virtual Reality technology will be used to link all raw materials production functions underpinned by Cyber-Physical Systems (CPS)/Industrial Internet of Things (IIoT).
- Biotechnology will see a huge increase in research and development for extracting metals through biological processes.
- Improvements on professional competences will come about much more on improving 'exploration thinking' rather than data processing – a computer is not the solution to discovering ore.
- Professionals will have to effectively operate in predictive exploration platforms that use analytics, modelling and simulation to identify targets in largely unexplored global regions with minimal (or no) drilling.
- Geophysical and geochemical knowledge in parallel with data sciences, modelling and geographic information system (GIS) skills will be a requirement for geologists working in mining.
- New and improved techniques for waste retreatment and processing will be developed for multiple commodities with multiple applications – dedicated, competent professions will deal exclusively with tailings re-use as well as working together with downstream users for identification of new products and applications.
- Sustainability professional roles will be consolidated including competences in social and environmental performance, Corporate Social Responsibility and post-mine rehabilitation and restoration.
- Future leaders in mining will have greater socio-environmental awareness and will objectively influence how value is perceived in mining.
- Education system will be revolutionized, moving from certification and general preparation to a flexible needs-based education – professionals won't have fixed professions, but lifelong learning, developing a dynamic portfolio of abilities and skills
- Professionals will be more demanded in scientific education (physics, mathematics and chemistry), as well as higher cognitive skills such as creativity and critical thinking, than technological skills.

It is well established that employers focus on different professional development approaches for closing skills gaps. Namely, through re-skilling, up-skilling, mentoring, partnerships with universities and training centres. However, it must be noted that the degree of impact that current and near-future trends might have in the future of raw materials companies can also give rise to new operating and business models. Therefore, ongoing feedback of emerging needs in the sector and raw materials employers at large is key for training centres and universities to strategically adapt and timely respond to these needs by adjusting curricula. The MOBI-US mobility programme shall take the skills needs described in this sub-chapter and build its curricula to cover those needs. This

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will facilitate the integration of raw materials qualified professions into the job market of the ESEE region.

3.3. Integrated competency model for employment across the raw materials sector

Based on new knowledge, skills and competences needed for the raw materials sector industries, the INTERMIN project developed a new competency model (a competency model is a framework for defining the skill and knowledge requirements of a job; it is a collection of competencies that jointly define successful job performance) for employment in the raw materials sector. As it is based on the same needs and gaps that are faced by ESEE raw materials related industries, the INTERMIN competency model can be appropriated to MOBI-US. The competency model for the raw materials education industry and, therefore education systems, is as follows (Table 3; adapted to the MOBI-US vision). It is based on three areas of the raw materials value chain that are recurrent in this chapter, as well as what WP1 aims: a) Mineral exploration, b) Mineral exploitation and processing and c) Material engineering and recycling. Four different competences groups are considered for each one of these areas: 1) Raw materials competences, 2) Management competences, 3) Conceptual competences and 4) Implementation competences.

Table 3: INTERMIN project's competency model for the raw materials sector and competences covered by the MOBI-US network partners

	Mineral exploration	Mineral exploitation and processing	Material engineering and recycling
Raw Materials competences	-Advanced data analytics and simulation modelling in synergy with orebody formation and geological processes in 4D **(AGH, WUST)** -Mineral exploration for new frontier mining e.g. deep sea and space resources **(AGH)**	-Industrial ecology **(UniZg-RGNF, AGH)** -Deep rock engineering/Geomechanics **(UniZg-RGNF, AGH, UNIM, WUST)** -Advanced data analytics and simulation modelling **(UNIM)** -Responsible mining due diligence **(UniZg-RGNF, AGH, WUST)**	-Investigation and development of new materials and processes **(UniZg-RGNF, AGH, UNIM)** -Advanced data analytics and simulation modelling **(UNIM)**
Management competences	-Social mechanisms of	-Market forecasting and Modelling **(AGH)**	-Supervision and/or operation of

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	Community engagement from exploration **(UniZg-RGNF, AGH, UNIM)** -Project management methodologies **(UniZg-RGNF, AGH, UNIM, WUST)**	-Blockchain embedded smart contracts -Social license to operate' **(AGH, UNIM)** -Project management methodologies **(AGH, UNIM, WUST)**	recycling plants **(UniZg-RGNF, AGH, UNIM)** -Project management methodologies **(UniZg-RGNF, AGH, UNIM)**
Conceptual competences	-Systems thinking **(UniZg-RGNF, UNIM)** -Knowledge of principles of sustainable development **(UniZg-RGNF, AGH, UNIM, WUST)**	-Advanced/ predictive data analytics, digital twinning and simulation modelling **(WUST)** -Systems engineering -Deep-water engineering **(AGH)** -Knowledge of principles of sustainable development **(UniZg-RGNF, AGH, UNIM, WUST)**	-Recycling markets and regulations **(UniZg-RGNF, AGH, UNIM)** -Knowledge of principles of sustainable development **(UniZg-RGNF, AGH)**
Implementation competences	-Application of principles of sustainable development **(UniZg-RGNF, AGH, UNIM, WUST)**	-In-situ leaching **(AGH, UNIM)** -Biotechnology **(AGH)** -Nanotechnology. -Deep-water engineering -Electrometallurgy -Environmental and social best practices as well as risk management strategies and plans. **(UniZg-RGNF, AGH, UNIM, WUST)** -Application of principles of sustainable development **(UniZg-RGNF, AGH, UNIM, WUST)**	-Application of principles of sustainable development **(UniZg-RGNF, AGH)**

Supporting the above competence model structure for the raw materials sector is the identified skill and competence gaps in the sector, where these lacking items were compared to the current offered skills to analyse what is missing from today education and how it should be tailored for employers' needs. Skills and competences changes foreseeable in the future are mostly related to technological evolution and social and environmental impacts management. Generic health and social tasks are expected to gain increasing importance across the raw materials value chain. Communication, creative thinking and problem-solving skills, sustainability and teamwork are job competencies that are becoming more important across different raw materials professions and organisations.

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Skills, within the MOBI-US scope, are most relevant in three distinct, although complementary, areas of the raw materials value chain. The needs of adaptation and emergence of competencies lie in:

a) Mineral exploration

Mineral exploration activities including exploration targeting, sampling, orebody modelling and resources estimation will be affected by the increasing prospects of integrating and processing data from disparate and multi-datasets, which in turn will improve mineral exploration. Machine learning will also become more important with increased applications integrated to more sophisticated 3D visualisation software. These will be able to integrate data acquired with novel technologies such as hyperspectral core imaging and autonomous drilling combined with improved remote sensing technologies.

b) Mining and processing

Mining operations give great amounts of data of different kinds, which are prone to lever digital solutions that can integrate such data. That is the case for the combination of Industrial Internet of Things concepts (Digital twins, 3D simulation and modelling, Machine Learning and AI) with more autonomous mining systems. The consequence of this is/will be a bigger number of decision support systems and remote operating systems, which in turn mean that more raw materials professionals will need to work within these facilities.

Systems engineering and other disciplines will likely translate into more autonomy and lifecycle-oriented systems approaches that will need study and analysis on systems requirements such as decommissioning and mine closure and reclamation. Furthermore, operations will receive increasing attention on end-to-end productivity optimisation, with more integrated decision-making approaches with increased asset management applications

c) Materials engineering and recycling

Circular economy, which are transversal to the previous two elements of the raw materials sector, requires new skills and competences based on more research efforts for new materials applications, secondary processing technologies and techniques, new business approaches that support circularity as well as new policies and regulations. Due to these areas' needs, where skills and competences will increase, and where professional training will face some gaps, it is needed to identify, control and solve these bottlenecks in advance.

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Adding to the above considerations, some assessments of skills needs in the raw materials sector showcase that a decrease in physical and manual skills needs is expected, whilst social and emotional skills and technological skills are expected to be demanded increasingly. The effect of the suggested changes will be felt strongly by lower level occupations and skills - routine work demand is expected to decrease while higher level thinking to anticipate and plan activities is expected to increase.

Specifically, for the three areas mentioned above (exploration, mining and processing, and engineering and recycling), Table 4 showcases what are the most affected actions within those fields and what kind of adaptations are needed to solve those bottlenecks:

Table 4: Adaptation needs in skills and competences for relevant areas of raw materials and how they are currently supported by MOBI-US network partners.

Field	Most affected areas	Adaptation needs
Mineral exploration	-Targeting, identification and delineation of mineralisation -Exploration design -Field geology -Geo-spatial modelling	-Advanced data analytics and simulation modelling in synergy with better understanding of orebody formation and geological processes in 4D. **(UniZg-RGNF, AGH, UNIM, WUST)** -Knowledge and application of principles of sustainable development **(UNIM, WUST)** -Social mechanisms of community engagement from exploration campaigns downstream **(AGH)** -Mineral exploration for new frontier mining e.g. deep sea and space resources. **(UniZg-RGNF, AGH)**
Mining and processing	-Drill & Blast processes, technical execution – more focus on decision support -Mining geology – less need for on-site presence -Deep rock engineering – more demand for geotechnical engineers and modellers -Mining systems – more autonomous systems will be designed and deployed -Asset management	-Advanced/ predictive data analytics, digital twinning and simulation modelling **(UniZg-RGNF, AGH)** -Systems engineering – managing increased complexity of planning, scheduling and advanced decision-making **(AGH, WUST)** -Business and operating models: more customer-centric approaches, improved market forecasting and modelling, and blockchain embedded smart contracts application **(UniZg-RGNF, AGH)** -Extreme environments: deeper underground mines will require a more complex combination of competencies in geotechnics, hydrogeology, mechatronics and automation. **(UniZg-RGNF, AGH)**

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	-Product marketing -Community engagement towards embedded social responsibility in all mining extraction and processing activities. -Supply chain due diligence – conflict minerals	-Business management: deep understanding of 'Social License to Operate', how to implement environmental and social best practices as well as risk management strategies and plans. **(UniZg-RGNF, AGH, UNIM, WUST)** -Emerging techniques and technologies for extraction: increased demand for in-situ leaching specialists, biotechnology. Open-up of new fields such as nanotechnology. **(UniZg-RGNF, AGH, UNIM)** -Deep-water engineering skills for designing, implementing and operating deep sea mining projects. **(UniZg-RGNF, AGH)** -Industrial ecology skills: understand the complex web of interactions raw materials are part of and is a person able to apply tools aligned with the optimisation of the total raw materials cycle, including resources, energy and capital requirements **(AGH, UNIM)**
Materials engineering and recycling	Processing technologies	-Investigation and development of new materials and processes **(UniZg-RGNF, AGH, UNIM)** -Strong understanding of circular economy principles and recycling markets. **(UniZg-RGNF, AGH)** -Regulatory knowledge for secondary raw materials **(UNIM)** -Supervision and/or operation of recycling plants **(UNIM)**

The adaptation needs suggested for these three areas shall be taken into account by MOBI-US when building its mobility programmes as well, as these skills and competences are likely to be needed by the future workforce of the raw materials sector related industries. These shall be aligned with the competences list mention before and introduced in the master's curricula offered by the networking universities in the ESEE region. The rise of new competences, coming from the industry needs, will drive the adaptation of the education, and MOBI-US can help its students to be better prepared for such a future market.

Analysing these data, it is seen that different network partners offer different competences at this moment. It is therefore needed – as is the aim of the project – to offer an integrated set of competences by different institutions so that all can benefit from a wide pool of competencies, seen as a way to support better learning, training and preparation of the future workforce (Figure

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5). While universities show strong competence offering on mineral exploration and exploitation (areas with long tradition), they are lacking in competences related to more recent developed areas such as mineral processing and recycling.

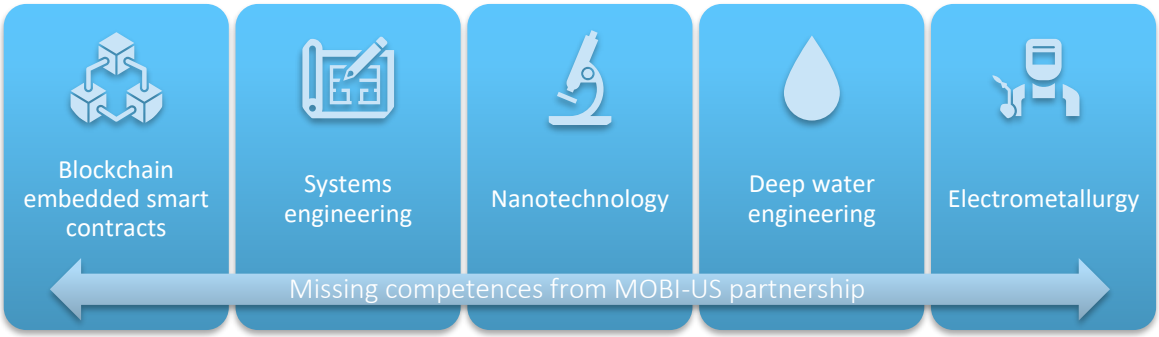

Figure 5: Competences missing from MOBI-US networking partners that will need to be acquired with the participation of external universities.

3.4. International qualification framework for the raw materials sector – the Sectoral Qualifications Framework for the Raw Materials Sector (SQF-RM) approach

Based on its findings (needs for skills, competences, mobility, and others in the raw materials value chain), INTERMIN proposes a new qualification framework that will allow raw materials education and training centres around Europe and the world alike to have a same approach that facilitates and integrates the mobility of students and raw materials professionals and the acquiring of skills, competences and knowledge. This framework, although aimed at international level, will at the same time have a big impact in the EU qualification framework. A framework such as the one proposed can be uptaken by the networking partners universities courses while the same could be extended to other parties involved in the future mobility programs of MOBI-US. This would facilitate the project's goals towards common recognition of skills, competences and knowledge, especially when these are prone to changes in the near future, changes that are not currently covered by the EQF framework. This vision would also be able to offer more support to the needs of the raw materials industry in the ESEE region, supported by an integrated competences and skill framework adequate to the current and future needs.

The sectoral qualifications framework for the raw materials sector (SQF-RM) proposed by INTERMIN, improves relevance, transparency and coherence between qualifications along the

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minerals value chain and the corresponding international recognition in support of the free flow of workers between regions and industry. The SQF-RM is therefore adequate to the MOBI-US masters programmes mobility, where the pilot universities shall showcase how collaboration and interaction among different countries and education establishments, with different offers in skills and competences, can support the future needs bottlenecks that the raw materials industries are likely to face.

INTERMIN's SQF-RM mirrors the EQF (European Qualification Framework), in some respects, since the first has its roots in the latter. One of those is that it still uses a comprehensive competency model for employment across the raw materials sector using a common reference framework of qualifications, expressed as learning outcomes at increasing levels of proficiency (the competency model is suggested in the previous sub-chapter). By mirroring the EQF, the SQF-RM facilitates the adaptation of professional development models, and education and employee training programmes to the requirements of the changing labour market.

The same three areas proposed in the previous sub-chapter are used in this case:

a) Mineral exploration
b) Mineral extraction and processing
c) Material engineering and recycling of waste

To facilitate the definition of key competences for the SQF-RM, INTERMIN uses the following definition of competences: *the necessary prerequisites for meeting complex demands*. The key competences for the SQF-RM combine competences specific to the raw material industry with functional and personal competences required in professional contexts. Table 5 shows the seven key competences considered in the SQF-RM, divided among the three areas and their sub-areas:

Table 5: Competences considered in the Sectoral Qualification Framework – Raw Materials

Area	Subarea	Competences
-Mineral exploration	-Exploration logistics and planning -Surveying and mapping -Legal and regulatory requirements -Acquisition, manipulation and analysis of digital terrain data for geological applications -Drilling and sampling techniques -Distribution of elements in rocks, soils, sediments, etc in relation to mineralization -Geophysical methods applied to exploration -Property and prospect evaluation	-The ability to communicate clearly verbally and in writing -Mathematical competence and competences in science and technology -General understanding of sustainability and materials & energy efficiency

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	-Community relations	-General understanding of the raw material value chain -Knowledge and understanding of geological processes in space and time -Digital competence -Knowledge of and commitment to safe working practices
-Mineral extraction and processing	-Permitting -Mine design and planning -Procurement -Mine development -Ore extraction and ore processing -Environmental assessment and management -Waste disposal and site restoration -Cost monitoring -Human Resources management -Corporate social responsibility -Data management / digital technologies -Geotechnics -Mining technologies -Community relations	
-Materials engineering and recycling	-Materials science -Metallography and crystallography -Extractive metallurgy -Metalworking -Collection, crushing and shredding -Separation, melting and purification -Cost monitoring -Human Resources management -Corporate social responsibility	

Based on current skills and future gaps in competences for the raw materials sector, a set of level descriptors for the raw materials education system was suggested. This is based in three areas of high interest: 1) Mineral exploration, 2) Mineral extraction and processing and 3) Material engineering and recycling. Despite having level descriptors for different levels, here are only transcribed the ones that are of importance for the MOBI-US project, i.e., the ones the that are translated to the Masters Programmes levels (Correia et al., 2019).

Mineral exploration (level 7 – Masters degree = EQF)

General knowledge – knows and understands:

- professional and ethical responsibilities of professional geoscientists;
- the interdependencies of value chains based on mineral raw materials;
- the complex dependencies between economic effectiveness and data obtention, processing, modelling and simulation;

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- the complex dependencies between safety and functionality of the work, economic effectiveness and data obtention, data processing, modelling and simulation;
- communicative English.

General skills – is able to:

- solve complex, non-routine problems of mineral exploration programmes;
- design unique mineral exploration projects in accordance with best practice and the requirements of laws and norms;
- organise working plans and forecasts, and his/her own working time and that of subordinate people;
- train team members, subordinate employees and subcontractors;
- independently perform functions and activities relating to contract management, including:
    - using IT tools;
    - writing and talking in English;
    - measure performance and control deviations;
    - motivate team members and subordinate employees.

General social competence – is ready to:

- take responsibility and demonstrate innovativeness;
- motivate employees to adopt best practices;
- work with and motivate a team under pressure;
- implement best practices and establish good interpersonal relations with all relevant stakeholders;
- undertake initiatives aimed at improving effectiveness and financial results.

Occupational knowledge – knows and understands:

- the provisions of exploration contracts, including the rights and obligations of its participants;
- in depth, the regulations applicable to mineral exploration programmes;
- the specific norms and requirements of site and property management applicable in the scope of a contract, and the corresponding environmental and social obligations;
- the application of methods and techniques of mineral exploration to improve the processes of mineral extraction and processing.

Occupational skills – is able to:

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- design mineral exploration programmes, using different methods and technologies in a manner consistent with budget and client's goals and requirements;
- manages, controls and assesses the implementation of exploration programmes;
- prepare reports of mineral exploration programmes in a manner consistent with existing reporting codes and norms;
- prepare mineral exploration contracts and the corresponding technical documentation.

Occupational social competence – is ready to:

- design and manage mineral exploration programmes;
- organise the participation of persons with relevant knowledge, qualifications and competence in preparing contracts;
- fully use his/her specialised knowledge and skills in the design, implementation and follow up of exploration programmes;
- assume responsibility for mineral exploration programmes;
- properly assess opportunities and counteract threats in the implementation of exploration programmes.

The holder of an SQF-RM Level 7 qualification works, for the most part, in the following areas:

a) Geophysical or geochemical exploration programmes;
b) Exploration drilling;
c) Laboratory testing;
d) Classification and evaluation of mineral deposits.

Example of a position requiring qualifications at this level: Senior Exploration Geologist; Senior Project Manager; Mineral Potential Supervisor; Geologists Supervisor.

Mineral extraction and processing (level 7 – Masters degree = EQF)

General knowledge – knows and understands:

- professional and ethical responsibilities of professional geoscientists;
- the interdependencies of value chains based on mineral raw materials;
- the complex dependencies between economic effectiveness and data obtention, processing,
- modelling and simulation;
- the complex dependencies between safety and functionality of the work, economic
- effectiveness and data obtention, data processing, modelling and simulation;

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- communicative English.

General skills – is able to:

- solve complex, non-routine problems of mineral extraction and/or processing;
- design and implement mineral extraction and/or processing operations in accordance with best practice and the requirements of laws and norms;
- organise working plans and forecasts, and his/her own working time and that of subordinate people;
- train team members, subordinate employees and subcontractors;
- independently perform functions and activities relating to contract management, including:
    - using IT tools,
    - writing and talking in English;
    - measure performance and control deviations;
    - motivate team members and subordinate employees.

General social competence – is ready to:

- take responsibility and demonstrate innovativeness;
- motivate employees to adopt best practices;
- work with and motivate a team under pressure;
- implement best practices and establish good interpersonal relations with all relevant stakeholders;
- undertake initiatives aimed at improving effectiveness and financial results.

Occupational knowledge – knows and understands:

- the provisions of mining contracts, including the rights and obligations of its participants;
- the regulations applicable to mineral extraction and/or processing activities;
- the specific norms and requirements of site and property management applicable in the
- scope of a mining contract, and the corresponding environmental and social obligations.

Occupational skills – is able to:

- combining different methods and technologies of plan mineral extraction and/or processing
- activities, in a manner consistent with budget and client's goals and requirements; manages, controls and assesses mineral extraction and/or processing activities;
- prepare reports on mineral extraction and/or processing in a manner consistent with existing

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- reporting codes and norms.

Occupational social competence – is ready to:

- manage mineral extraction and/or processing activities;
- organise the participation of persons with relevant knowledge, qualifications and competence in preparing contracts;
- fully use his/her specialised knowledge and skills in the design, implementation and follow up of mineral extraction and/or processing activities;
- assume responsibility for mineral extraction and/or processing activities;
- properly assess opportunities and counteract threats in the implementation of mineral extraction and/or processing activities.

The holder of an SQF-RM Level 7 qualification works, for the most part, in the following areas:

a) Geophysical or geochemical exploration programmes;
b) Classification and evaluation of mineral deposits.
c) Mining and quarrying;
d) Mineral processing;
e) Management.

Example of a position requiring qualifications at this level: Senior Mine Geologist; Senior Mine Engineer, Environmental Coordinator; Metallurgical Engineer; Mine/Quarry Manager.

Material engineering and recycling (level 7 – Masters degree = EQF)

General knowledge – knows and understands:

- professional and ethical responsibilities of registered professionals;
- the interdependencies of value chains based on mineral raw materials;
- the complex dependencies between safety and functionality of the work, economic effectiveness and data obtention, data processing, modelling and simulation;
- communicative English.

General skills – is able to:

- solve complex, non-routine problems of metal production and/or recycling;
- design and implement metal production and/or recycling operations in accordance with best practice and the requirements of laws and norms;

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- organise working plans and forecasts, and his/her own working time and that of subordinate people;
- train team members, subordinate employees and subcontractors;
- independently perform functions and activities relating to contract management, including:
    - using IT tools,
    - writing and talking in English;
    - measure performance and control deviations;
    - motivate team members and subordinate employees.

General social competence – is ready to:

- take responsibility and demonstrate innovativeness;
- motivate employees to adopt best practices;
- work with and motive a team under pressure;
- implement best practices and establish good interpersonal relations with all relevant stakeholders;
- undertake initiatives aimed at improving effectiveness and financial results.

Occupational knowledge – knows and understands:

- the regulations applicable to metal production and/or recycling activities;
- the specific norms and requirements of site and property management applicable in the
- scope of metal production and/or recycling, and the corresponding environmental and social obligations.

Occupational skills – is able to:

- combining different methods and technologies of metal production and/or recycling activities, in a manner consistent with budget and client's goals and requirements;
- manages, controls and assesses metal production and/or recycling activities;
- prepare reports on metal production and/or recycling in a manner consistent with existing reporting codes and norms.

Occupational social competence – is ready to:

- manage metal production and/or recycling activities;
- organise the participation of persons with relevant knowledge, qualifications and competence in preparing contracts;
- fully use his/her specialised knowledge and skills in the design, implementation and follow up of metal production and/or recycling activities;

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- assume responsibility for metal production and/or recycling activities;
- properly assess opportunities and counteract threats in the implementation of metal production and/or recycling activities.

The holder of an SQF-RM Level 7 qualification works, for the most part, in the following areas:

a) Recycling
b) Smelting.

Example of a position requiring qualifications at this level: Senior Metallurgical Engineer; Senior Materials Engineer, Environmental Coordinator; Recycling Centre Coordinator, Smelting Inspector

The definition of these level descriptors is relevant for MOBI-US, as the project can then, based on these, better adapt their Masters programmes offers and extend the exchange programmes to cover and offer to the students a wide range of skills and competences (both technical and non-technical) that will better prepare the students for the market and that are inline with the industry needs as well as with European policies suggestions and requirements. This will in turn strengthen the raw materials sector as a whole. The ESEE region can greatly benefit from following such an approach.

The above skills and competences listed shall be taken into account by the university partners when drafting the masters programmes and mobility and shall, therefore, put in focus a mix of skills offered by different entities, that can help to cover has much skills gaps as possible.

Only with a common and shared approach will be possible for the project's aim to be concretized. The mobility program shall, after the MOBI-US project lifetime, extend to other universities that are offering/can offer/will offer skills and competences that the project networking universities are not capable of providing currently. One other option to complete the offer of required competences would be to involve raw materials training centres in the process, following the principle that, those too, would use the SQF-RM.

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4. Conclusions and recommendations

The analysis and knowledge transfer of the INTERMIN project on the European qualification framework, the skill and competences catalogue as well as the analysis on skills gaps for the raw materials sector lead to the development of a set of recommendations and suggestions for the application of such outcomes in MOBI-US that shall support and lead to a proper implementation of the project's goals in the ESEE region. Such recommendations are based on four main topics (in accordance with the objective of task 1.5 and with the referred projects):

- The skills catalogue developed for the raw materials sector (based on INTERMIN's D1.1)
- A report on skill gaps in the sector (Based on INTERMIN's D2.1)
- An integrated competency model for employment across the raw materials sector (based on INTERMIN's D2.2), and
- The International qualification framework for the raw materials sector (based on INTERMIN's D3.1).

The main conclusions and recommendations, for each of the previous items are specified next. MOBI-US shall implement and follow these as they are in line with policy and industry requirements for the future of the raw materials sector in the ESEE regions (also inline with the remaining deliverables of MOBI-US Work Package 1).

The skills catalogue developed for the raw materials sector

1) MOBI-US shall recur to INTERMIN's public online database to help find partner institutions - matchmaking. The importance for MOBI-US lies in the list of skills offered by the ESEE universities and training centres. The database offers the perfect pool of potential candidates for the extension of the mobility programs.
2) MOBI-US shall ensure a minimal threshold for any definition applied within the project. This threshold will not only ensure clarity for students and course/programme coordinators across countries but will also ensure that any student can be certain that the skills and competences he or she will acquire during his or her exchange period can be accepted as valid ECTs.
3) The MOBI-US program shall promise to be an equal opportunity program. A declaration signed by all network partners shall be signed. A survey can go hand-in-hand with the equality approach to better understand and steer the mobility programs in order to achieve a fruitful outcome.

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4) It is of relevance for MOBI-US to guarantee that the exchange and mobility programs will follow the value of T-shape professionals as they are an attractive and high demand commodity on the job market. The T-shape approach shall improve on some requirements including, but not limited to, new systemic innovations in areas of waste reduction, recycling, material efficiency and residue utilization. It is also necessary that professionals have a deep understanding of the raw materials system and the entire value chain.
5) All of the new skills defined within INTERMIN have some degree of importance in the current and future panorama for the raw materials sector and should, therefore, be fostered in the education and training of raw materials professionals. In the light of the MOBI-US mobility programs, these skills should take major importance.

Skill gaps in the raw materials sector

1) MOBI-US shall take into account the needs (skill gaps) of the raw materials sector in the short, medium and long-terms and adapt its mobility programs to cover these needs. The skill and competences gaps can be analysed in sub-chapter 3.2 and 3.3 of this deliverable.
2) MOBI-US shall monitor ongoing feedback of emerging needs in the sector and raw materials employers. The mobility programme can then be strategically adapted to be able to respond to these needs by adjusting curricula offered by the networking partners. It thus necessary that MOBI-US establishes a close relation with ESEE raw materials industries.

Integrated competency model for employment across the raw materials sector

1) MOBI-US shall guide the development and implementation of the mobility programme from INTERMIN's competency model. As it is based on the same needs and gaps that are faced by ESEE industries, the INTERMIN competency model can be appropriated to MOBI-US. The competency model is based on three areas of the raw materials value chain: 1) Mineral exploration, 2) Mineral exploitation and processing and 3) Material engineering and recycling. Four different competence groups are considered for each one of these areas: 1) Raw materials competences, 2) Management competences, 3) Conceptual competences, and 4) implementation competences.
2) MOBI-US shall try to solve the lack of competencies and the missing adaptation needs envisaged for the future of these three areas, which are mentioned in detail in sub-chapter 3.3 of this deliverable.

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1) MOBI-US can develop its new mobility programme inline with INTERMIN's proposed qualification framework: "sectoral qualifications framework for the raw materials sector" (SQF-RM). This framework, although aimed at international level, will at the same time have a big impact in the EU qualification framework. A framework such as the one proposed can be uptaken by the mentoring partners universities while the same could be extended to other parties involved in the future mobility programs of MOBI-US. This would facilitate the project's goals towards common recognition of skills, competences, and knowledge, especially when these are prone to changes in the near future, changes that are not currently covered by the EQF framework.
2) The SQF-RM propose new level descriptors for masters programmes, which MOBI-US masters programmes shall follow. The list of these descriptors for the three defined sub-areas of the raw materials sector can be studied in sub-chapter 3.4 of this deliverable.
3) The mobility program shall, after the MOBI-US project lifetime, extend to other universities that are offering/can offer/will offer skills and competences that the project networking universities are not capable of providing currently. One other option to complete the offer of required competences would be to involve raw materials training centres in the process.

The above conclusions/suggestions shall be taken into consideration within WP1 and transferred to other work packages during the MOBI-US implementation. They shall continue to be relevant even the project funding period is over. All the actions call for an integrated assessment by the networking partners that shall be supported by finding and matchmaking with new partners. The MOBI-US workshops will prove important in this regard.

A last consideration falls on the need to keep screening the raw materials sector for its development, needs, skill gaps and other aspects of relevance. Ways to do this screening and at the same time involve relevant stakeholders are the base of foresight studies, which shall be applied in the future – either during or after the project. Proposed foresight methods to keep MOBI-US inline with the raw materials sector facets include:

1) Desk research
2) Delphi Surveys
3) Focus groups

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