



CASE STUDY:

EIT RAWMATERIALS

ADVANCED MATERIALS FOR INNOVATIVE RECYCLING (AMIR)

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INTRODUCTION

OBJECTIVES OF THE CASE STUDY

This case study presents the **Master Programme Advanced Materials: Innovative Recycling (AMIR)**, created in response to a pressing need to **develop Europe's advanced materials recycling capabilities to increase secondary raw material supply to European industry.**

The case study notes the programme's goals, methods of implementation, as well as show how the programme has grown from its first edition in 2017. Particular attention is given to the **initiative's outstanding determination for development**, and its **networking** and **entrepreneurial potential**.

METHODOLOGY

The study involved conducting 9 one-on-one online **in-depth interviews** with 11 significant persons in charge of the planning and execution of the AMIR programme as well as with its beneficiaries.

- Education and Innovation Director, EIT RawMaterials.
- Coordinator of the AMIR programme.
- Academic Partners of the programme.
- EU & International Projects Office Managers at AMIR Coordination Office.
- Students and Alumni of the programme.

Additionally, the **documents** and **reports** regarding the implementation of AMIR programme as well as **information** shared on EIT RawMaterials and programme's website were examined, with special focus put on:

- EIT RawMaterials, The EIT-Labelled Master Programmes – brochure, 2020.
- AMIR Internal Budget 2021-23 summary.
- AMIR Master Course Syllabi (2021-23 edition onwards) for the AMIR Year 1&2 partner universities.
- AMIR and AMIR/AISS Summer Schools 2020-2021 Booklets.
- AISS Summer School Activity report 2019 & 2020.
- AMIR-RIS and AMIR-LIH Work Package Optimizations and reports on Work Package distribution among academic partners.
- Overview of AMIR programme student intakes and scholarship 2021-2025.
- AMIR Candidate Selection Procedure.
- AMIR Alumni Survey results.



RATIONALE FOR SELECTION OF THE CASE STUDY

As an **EIT Label programme**, the AMIR incorporates **advanced training in entrepreneurship and innovation** into its curriculum to equip students with the abilities they need to change the game in the recycling industry. The programme obtained the **Erasmus Mundus** Joint Master (EMJM) label in 2022 and was in the same year included in the **Top 10 Unique Study Programmes** by the European Commission.

AMIR case study was chosen based on the two strengths:

- AMIR is a strong illustration of the **knowledge triangle integration**: six university partners, five research partners, and industry partners (such as ArcelorMittal, Arkema, Veolia).
- Significant **entrepreneurship opportunities**: *Label StartUP* which provides students with direct, face-to-face training by entrepreneurs on the practical tools and knowledge to establish their own start-ups. *Labe-Launch!* is the graduation ceremony for all EIT-Label Master students which provides them with HR sessions with EIT RawMaterials partners, and soft skills workshops. *RACE* is a two-week challenge-based learning programme across the raw materials value chain that unites sustainability pioneers to connect, learn, and innovate for pressing raw materials challenges.

CONTACT INFORMATION

- Programme website: <https://www.amir-master.com/>
- Programme contact email address: amir.master@u-bordeaux.fr

INFORMATION ABOUT ACTIVITY

RATIONALE OF THE ACTIVITY: VALUE ADDED AND BENCHMARKING THE ACTIVITY WITH OTHER ACTIVITIES

AMIR Master Programme emerged as a **response to the challenges that Europe and other parts of the world will face in the coming years**, including the need to improve infrastructure, **reduce energy consumption** and **greenhouse gas emissions**, and **increase the use of renewable energy sources**.

There is a **growing demand for experts** in the field of raw materials, circular economy, recycling, and materials life cycle assessment, as the world looks for ways to **reduce waste**, improve **resource efficiency**, and transition to a more **sustainable economy**. The experts play a critical role in the development and implementation of strategies and technologies that enable the efficient use and reuse of materials throughout the entire value chain, from extraction and processing to end-of-life management¹.

¹ Interview conducted with representative of EIT RawMaterials, December 2022



To ensure the long-term sustainability of the materials cycle, it is important to adopt a **holistic and integrated approach** that considers the full life cycle of materials and considers the economic, social, and environmental implications of different options. This includes investing in research and development, promoting innovation, and supporting the development of new technologies and business models that can help to optimize resource efficiency and reduce waste.

For Europe to secure the raw materials supply, there is a need to provide **new talents** in mining, exploration and processing industry, recycling, and circular economy, especially that EU has designated thirty materials as essential, meaning they are both **critically crucial to the EU economy and dangerously in short supply**. While the availability of the known primary raw material sources has become more difficult, the number of industrial waste and end-of-life items is rising quickly. The secondary raw elements found in these waste streams, many of which are essential and can be recovered, help to diversify the supply, and provide useful materials to **satisfy rising demand**. To do this, **highly qualified experts** with in-depth technical knowledge of recycling, an awareness of the entire value chain of raw materials, and the abilities necessary to convert information into commercial solutions are needed².

My goal is to be an entrepreneur in the circular economy field. So that makes an amazing match between me and the AMIR Programme. (...) I really want to change the life of others with this master [programme], with this education here in Europe..

Student, AMIR Master Programme³

The AMIR programme was developed with a **long-term vision** in mind. The development of recycling infrastructure is a key component of a sustainable materials management system. Recycling plays a crucial role in conserving natural resources, reducing waste, and mitigating the environmental impacts of resource extraction and processing. However, it can take time to establish a robust recycling infrastructure, as it requires significant investments in technology, infrastructure, and human resources. It is common for it to take 15-20 years or more to develop the necessary infrastructure and systems to effectively recycle a particular material or product⁴.

Subsequent editions of the project have also responded to the **EIT Regional Innovation Scheme**, introduced to boost the innovation performance of countries with moderate or modest innovation scores.

² EIT RawMaterials GmbH. (2020). The EIT-Labelled Master's Programmes - brochure.

³ Interview conducted with beneficiary of AMIR Programme, December 2022

⁴ Interview conducted with representative of EIT RawMaterials, December 2022



Among other EIT RawMaterials Master Programmes that implement "T-shaped"⁵ approach, such as AMIS (Master in Advanced Materials for Innovation and Sustainability), EMerald (Master in Resources Engineering), RaMES (Master in Raw Materials Exploration), SINReM (International Master of Science in Sustainable and Innovative Natural Resource Management), SUMA (Master in Sustainable Materials), the AMIR programme stands out as one that will provide the market with graduates fully equipped to take on professional roles in various sectors: process optimisation, material design, and project administration.

On the one hand, the curriculum gives students a thorough understanding of **recycling technologies** as well as in-depth knowledge of materials science and engineering. On the other hand, courses in **entrepreneurship & innovation**, creativity & leadership, intellectual property and technology intelligence, as well as life cycle assessment and sustainability, integrate this knowledge with transferable skills⁶.

The programme added value is in **circularity, recycling and sustainability**, which appeals to the students who were not before interested in the area, who are not familiar with mining and raw materials exploration⁷.

I wanted to do master's in recycling technologies (...) It was a great opportunity because it got everything that I wanted. (...) [AMIR Programme] is combining the scientific and technical parts of recycling and sustainability and materials with more, let's say, wide sustainable perspective, which involves a lot more things than scientific, but is using science as a starting point.

Alumni, AMIR Master Programme⁸

Additionally, it encourages students to be **mobile**, as the programme requires students to spend one year in the partner HEI, as well as an internship at the company that maybe located in country other than their education institution.

DESCRIPTION OF ACTIVITY

The AMIR Master Programme is a **two-year, interdisciplinary programme** that aims to provide students with a broad understanding of the fundamental principles of materials science and engineering, as well as the knowledge and skills needed to apply these principles in the design and development of advanced materials for infrastructure and renewable energy systems. The programme consists of 4 **main elements** that form the basis of AMIR experience: **Higher education; Internship; Summer School and EIT RawMaterials activities.**

⁵ The T-shape approach emphasizes the development of both deep knowledge in a particular subject area (the vertical stem of the T) and broad interdisciplinary skills (the horizontal bar of the T). This approach aims to produce well-rounded graduates who are experts in their field and possess transferable skills.

⁶ AMIR-LIH: Master programme on Advanced Materials Innovative Recycling focused on Lighthouses - EIT RawMaterials, <https://eitrawmaterials.eu/project/amir-lih/>.

⁷ Interview conducted with representative of EIT RawMaterials, December 2022

⁸ Interview conducted with beneficiary of AMIR Programme, December 2022



PROGRAMME'S STRUCTURE

Higher education

The AMIR Master programme offers students the possibility of obtaining a **double diploma**⁹, which is a nationally accredited diploma from each of the two partner universities where they study. To achieve that, students can choose one of the two combinations of hosting institutions for their first and second year.

In option 1, the first year is at the University of Bordeaux and second year at either the Technical University of Madrid or TU Darmstadt. In option 2, the first year is at NOVA University Lisbon or the University of Miskolc and second year at either the Technical University of Madrid, TU Darmstadt or University of Liège¹⁰.

In the first year (Table 1), students acquire an understanding of the full raw materials value chain and develop a mindset for innovation and entrepreneurship. In the second year, students specialise in a study field of choice with one of AMIR's partner universities, followed by an internship with a research organisation, industrial partner, or academic partner. Each university specialises in different area of expertise and programme's website provides a comprehensive list of all classes offered by the HEI during two-years course¹¹.

⁹ AMIR - Master in Advanced Materials: Innovative Recycling, <https://www.amir-master.com/>

¹⁰ All combination of first year/second year are technically possible and will result in the issuance of a single diploma from the university attended during the first year.

¹¹ AMIR - Master in Advanced Materials: Innovative Recycling, <https://www.amir-master.com/>.



Table 1. AMIR programme options for a double Master's diploma

Option 1 for a double diploma	
First year	Second year
University of Bordeaux	Technical University of Madrid
	TU Darmstadt
Option 2 for a double diploma	
First year	Second year
NOVA University Lisbon	Technical University of Madrid
University of Miskolc	TU Darmstadt
	University of Liège

Source: EIT RawMaterials

Internship:

All students are required to follow an up to six-months long industry/research institution internship during the programme. Students can choose the internship based on their interests, either to be completed with one of the programme's partners or from the list of available internships provided on the learning platform Moodle¹².

[The internships] for me really marked my career and helped me to do the first steps, to get a lot of knowledge, contacts, opportunities. It's something that I always recommend to anyone. (...) I cannot imagine a master's where you can get more opportunities to get a job.

Alumni, AMIR Master Programme¹³

AMIR Summer School:

Students from AMIR and other EIT RawMaterials branded Master programmes are welcome to attend the AISS/AMIR Summer School.

The first edition, in 2019, occurred in Bordeaux in July (out of 48 participants 22 were from the AMIR programme). The second edition, in 2020, took place fully online in July 2020 (40 out of 46 were from AMIR). In 2021, it was organised in collaboration with REDLED (LED recycling, EIT RawMaterials) and

¹² Interview conducted with programme's beneficiary, December 2022.

¹³ Interview conducted with beneficiary of AMIR Programme, December 2022



PANORAMA (information service that maps the flows and stocks of materials) projects over June to July and was fully online¹⁴.

For next years AMIR Summer School will be organized annually, the participation of all year 1 students is mandatory. The Summer School aims to facilitate the development of the students professional integration and career perspectives in the market of raw materials, innovation and related ecosystems. It is also an opportunity for students to develop their personal networks and meet AMIR Programme alumni.

EIT RawMaterials activities:

Additionally, all students of AMIR programme are welcome to participate in EIT RawMaterials activities for their Master programmes students, to increase their entrepreneurial abilities:

- *Label Induction Days/Label Start-Up! Days/Label-Launch!*.
- *RACE* (challenge-based summer school for 70 students).
- *EIT Jumpstarter* (pre-accelerator programme).
- *Lab2Market* programme (aims to coach and mentor Master and PhD students to develop innovative solutions ready for market).
- *EIT RawMaterials Accelerator* (three-stage accelerator programme for start-ups with developed product)¹⁵.

For me, there are a lot of job opportunities, there is a lot of networking possibilities, not only in raw materials, but other branches. They're connected to raw materials - organisations, industry partners and academic partners. All of them are connected, interconnected. And this means that there is a very big network cluster for me. This is maybe the best thing about the programme.

Student, AMIR Master Programme¹⁶

DATES OF IMPLEMENTATION AND FUNDING ALLOCATED (INCLUDING THE EIT FUNDING)

The programme had 3 editions so far (Table 2).

Table 2. Editions of AMIR programme

1 st edition	AMIR	The pilot Advanced Materials Innovative Recycling Master Programme ¹⁷	1.01.2017 – 31.12.2019
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¹⁴ AMIR/AISS Summer School brochures (2020, 2021); AMIR, AISS Summer School Activity report 2019 & 2020, internal material.

¹⁵ EIT RawMaterials GmbH. (2020). The EIT-Labelled Master's Programmes - brochure.

¹⁶ Interview conducted with beneficiary of AMIR Programme, December 2022



2 nd edition	AMIR-RIS	The consolidated AMIR Master involving 6 European universities, together with 5 Research and Technology Organisations and 3 representative industrial partners. An extension to partners in Hungary and Portugal who belong to the ESEE/RIS regions. ¹⁸	1.01.2019 – 31.12.2021
3 rd edition	AMIR-LIH	AMIR-LIH expands teaching offers regarding the LightHouses (LIH) on Sustainable Materials for Future Mobility and on Raw Materials and Circular Societies. ¹⁹	1.01.2021 – 31.07.2025

Source: EIT RawMaterials

So far, the AMIR Programme has received a total of €2,268,893 in EIT funding (€108,647 in 2017; €146,960 in 2018; €432,279 in 2019; €552 620 in 2020; €554,763 in 2021 and €473,624 in 2022; see Table 2).

The programme also demonstrates a strong ability to attract additional funding from European or national sources, while not falling under double financing, and instead introducing a strategy of diversifying revenues. From 2022 AMIR has successfully become an Erasmus Mundus Joint Master programme, which allowed to double the number of students enrolled in the programme ²⁰.

Those sources of funding – EIT RawMaterials, Erasmus Mundus and national funding that were introduced in subsequent programme editions – are treated as complementary, without the risk of overlapping. Students cannot receive scholarships from both sources at once. For this reason, a selection procedure has been introduced, to ensure transparency in awarding scholarships to students ²¹.

INFORMATION ABOUT PLANNED KPIS AND OUTPUTS

Plans for subsequent editions indicate the growth of the programme, which has more than tripled the planned number of students since its inception, as presented in Table 3.²²

Table 3. Planned target of students

	Planned target of students per cohort	
2017-2019	AMIR	14
2019-2021	AMIR-RIS	32
2021-2025	AMIR-LIH	48

¹⁷ EIT RawMaterials projects website: AMIR (<https://eitrawmaterials.eu/project/amir/>)

¹⁸ EIT RawMaterials projects website: AMIR-RIS (<https://eitrawmaterials.eu/project/amir-ris-master-in-advanced-materials-innovative-recycling-extended-by-an-ris/>)

¹⁹ EIT RawMaterials projects website: AMIR-LIH (<https://eitrawmaterials.eu/project/amir-lih/>)

²⁰ Ibid.

²¹ Interview conducted with programme's manager, December 2022

²² EIT RawMaterials projects websites: AMIR (<https://eitrawmaterials.eu/project/amir/>), AMIR-RIS (<https://eitrawmaterials.eu/project/amir-ris-master-in-advanced-materials-innovative-recycling-extended-by-an-ris/>), AMIR-LIH (<https://eitrawmaterials.eu/project/amir-lih/>).



Source: EIT RawMaterials

The programme has one KPI, introduced in 2019 - to have one start-up created by programme's graduate by 2024²³.

PRESENTATION OF PARTNERS. KNOWLEDGE TRIANGLE APPROACH

The base on which the AMIR was built has remained the same in subsequent editions, but two additional HEIs from RIS countries have been added in 2019. Currently, AMIR-LIH has 6 higher education institutions, 3 industry, and 5 research partners from 4 EU countries (Table 4).

Table 4. Programme's partners: HEI, industry, RTO

Edition	HEI		Industry	RTO		
AMIR	University of Bordeaux	France	ArcelorMittal Arkema Veolia ²⁴	Agencia Estatal Consejo Superior de Investigaciones Científicas	Spain	
	Technical University Darmstadt	Germany		Fundación Tecnalia	Spain	
	University of Liège	Belgium		Commissariat à l'Énergie Atomique et aux Énergies Renouvelables	France	
	Technical University of Madrid	Spain		Centre de Recherches Métallurgiques	Belgium	
AMIR-RIS/AMIR-LIH	University of Bordeaux	France		ArcelorMittal Arkema Veolia ²⁴	Fraunhofer-Gesellschaft	Germany
	Technical University Darmstadt	Germany				
	University of Liège	Belgium				
	Technical University of Madrid	Spain				
	University of Miskolc	Hungary				
	Universidade Nova de Lisboa	Portugal				

Source: EIT RawMaterials

Industry and research institutions are doubly involved in the programme: they provide internships and industry seminars to students enrolled in AMIR programme.

These experiences not only provide students with practical skills and exposure to their field, but also support the **"T-shape" approach** by emphasizing both deep knowledge in a particular subject area and

²³ EIT RawMaterials, *AMIR Master Programme, KPIs and outputs*. Internal material.

²⁴ From 2021 onwards one of the partners went from full partner to associate partner, AMIR Master Programme, KPI and outputs. Internal material.



broad interdisciplinary skills²⁵. This closely aligns with the **KIC**'s focus on the interplay between education, research, and innovation.

Currently, in the AMIR-LIH edition of the programme, industrial/RTO partners (Veolia, ArcelorMittal, CEA, CSIC and CRM) are involved as participants, given their role in the delivery of the **Industrial Seminars** during the Master year 1 in Bordeaux, the Master year 2 in Madrid (CSIC) and Liège (CRM), and are expected to participate in at least one meeting of the programmes' Steering Committee during the project's lifespan²⁶.

At the same time, students can do internships at other institutions that do not have an official partnership with AMIR. There are different rules regarding the financial compensation of students (in France, for example, the salary for an internship of less than 3 months is forbidden²⁷), or in which country the internship is to take place, or at what time it should be done (during the vacations or during the academic year). Due to the international nature of the programme, whose students also come from non-European countries, this can be a difficulty.

The **Industry Seminars** and internships help students build their professional networks and gain a better understanding of the industry or research sector in which they are interested. Internships and industry seminars are a way for students to apply the knowledge and skills they have learned in their academic studies to real-world situations, increasing their entrepreneurial potential.

PRESENTATION OF BENEFICIARIES

The focus group of the AMIR programme are students who are interested in full chain of raw materials but particularly in becoming an **entrepreneur** or intrapreneur in the sustainable economy sector. The programme's curriculum design that includes **classes on entrepreneurship and leadership** encourages the development of **business skills**. In addition, EIT RawMaterials designed and implemented entrepreneurship programmes (to which AMIR students have access) such as **RACE**, **Jumpstarter**, and **Lab2Market** addressing the talent need especially in the deep tech field.

The programme's activities over the course of its development **are directed to make it easier for students from around the world to participate**. Although there is a fee (2,000 EUR annually for EU students and 4,000 EUR for non-EU students), tuition is the same regardless of the universities chosen²⁸. Students of the programme currently receive scholarships, either from EIT RawMaterials (AVSA grants) or Erasmus Mundus scheme. In the 2022-2024 programme intake, 17 students received Erasmus Mundus scholarships and 21 EIT scholarships.

²⁵ EIT RawMaterials GmbH. (2020). The EIT-Labelled Master's Programmes – brochure.

²⁶ EIT RawMaterials, AMIR-LIH Work Package Optimization. Report on the rebalancing of the WP distribution among the academic partners. Internal material.

²⁷ Interviews conducted with programme's beneficiary, December 2022

²⁸ EIT RawMaterials, *AMIR Internal Budget 2021-2022, 2022-2023*. Internal material.



IMPLEMENTATION OF THE ACTIVITY

IMPLEMENTATION PROCESS

The implementation of the programme started with the first edition named 'AMIR' during the 2017/2018 and 2018/2019 academic years. Four academic partners participated in that edition: the University of Bordeaux, University of Liege, Technical University Darmstadt, and Technical University Madrid. The second edition – 'AMIR-RIS' – was implemented during the 2019/2020 and 2020/2021 academic years. In that edition, partners from European countries from Regional Innovation Scheme area (countries with moderate or modest innovation scores) joined the programme: University of Miskolc and NOVA University Lisbon. The current edition is part of the 'AMIR-LIH' project, implemented from 2021 and planned until 2025. It will cover three two-year study periods.

In each edition, the programme involved spending the first year of Master studies at one university, and the second at another. In AMIR, the first year was implemented in Bordeaux, and the second in Liege, Darmstadt or Madrid. AMIR-RIS added the option of spending the first year in Lisbon and the second year in Miskolc and in AMIR-LIH Miskolc became a first-year partner. In all editions, students were offered a scholarship that provided support during their studies.

ACHIEVED OUTPUTS AND KPIS

Since the AMIR programme started, 137 students participated in the studies (Table 2). By 2022, 82 of them graduated and others are in their first year Master's. Although data about careers of alumni is not tracked in detail yet (AMIR coordination team is working on an online student tracking system that should be available by September 2023), AMIR estimates that 95% of beneficiaries are employed within six months of graduation and 90% of beneficiaries are employed in a sector relevant to the area of the KIC. For all the 6 EIT labelled Master programmes, 67% of graduates start working in the raw materials industry and raw materials related industry including consultancy; 25% stay in academia to continue with PhD education, and 8% start working for a research and technology organization.

EIT RawMaterials has much effort in attracting the young generation particular female students to the STEM and Raw Materials sector. One of the flagship programmes is the *Girls Go Circular*²⁹ project that aims to equip 40,000 schoolgirls aged 14-19 across Europe with digital and entrepreneurial skills by 2024 through an online learning programme about the circular economy. This initiative among others has helped to close the gender gap in raw materials education (Table 5). Across all EIT labelled master programmes 37% are female graduates. Also 2022 *RACE* edition had 39% female participation³⁰.

²⁹ <https://eit-girlsgocircular.eu/>.

³⁰ Data provided with EIT RawMaterials Education and Innovation Director through email communication, January 2023.



Table 5. Number of students and graduates of the AMIR programme

	2018 / I edition	2019	2020	2021	2022 ³¹	Total
Beneficiaries attending the AMIR Master Programme	17/ 121, 43% target value	26	30/ 93, 75% target value	26	38 ³²	137
Women	6	12	14	15	15	62
Men	11	14	16	11	23	75
Graduates of the AMIR Master Programme	-	10	19	26	27	82
Women	-	1	7	12	12	32
Men	-	9	11	14	15	49

Source: data provided by AMIR

AMIR is implemented by partners representing higher education institutions, research organisations and the business sector, as detailed in Table 6. The programme does not include formal partnerships with public sector institutions, international organisations, or NGOs, as it was not planned in any edition of the programme so far.

Table 6. Number of AMIR programme partners

Institution type	2017	2018	2019	2020	2021	2022
Research organisations	5	5	5	5	5	5
Business ³²	3	3	3	3	2	2
HEIs	5	5	6	6	6	6

Source: data provided by AMIR.

AMIR has set a specific KPI of creating one start-up by its graduate for 2024. This KPI is not achieved yet but several actions had been taken by the AMIR master programme to support and promote entrepreneurship among current students and alumni. Each student is supported by a student incubator from the partner's universities, to help them develop their business idea and are being helped by the partners (providing contacts, internship opportunities etc). As of 2021, three students have already participated in EIT *Jumpstarter* and are now working on the development of their start-up idea, and the programme has yielded a successful scale-up project, the Triple Link project³³, which was created in 2020. In the 2022 *Jumpstarter* edition, two AMIR students with a recycling app idea, *Idea Crecycle*³⁴, made it to the final round.

³¹ In 2022, 38 students enrolled in the AMIR master programme including 21 students with the EIT scholarship and 17 with the Erasmus Mundus Scholarship. Indeed in 2021, the AMIR Master programme obtained the Erasmus Mundus Joint Master funding and labelling for 6 years.

³² From full partners until 2021 to associates partners since 2022 (partners by not signatory of the AMIR LIH consortium agreement)



IDENTIFIED VALUE ADDED

The added value of the AMIR programme lies in **bringing together** and **bridging disciplines, competencies** and **partners**, with the overarching goal of building one of the leading programmes within the fields of raw materials and recycling. The programme's unique proposition entails knowledge of the entire value chain related to raw materials and an overview of the materials sector, set into the context of current issues such as circular economy, sustainability and recycling. This is achieved by integrating into the curriculum STEM courses, such as chemistry, materials, and physics, with courses belonging to the social sciences, focusing on sustainability, economy, entrepreneurship and project management.

As the interviewed stakeholders argued, AMIR offers students **comprehensive knowledge and education** about the **value chain of raw materials**, which are **fundamental** to virtually **all industries** in developed economies. Importantly, students also learn about innovation and entrepreneurship, and through the multiple activities offered by the programme being part of EIT RawMaterials, gain support in developing new ideas, activities or creating start-ups. EIT-funded activities also provide opportunity for networking, which brings further added value.

Its added value is also represented by its approach to **teaching methods**. As interviewees noted, in its entirety, AMIR is a **unique, different way** of looking at a Master **programme in comparison to what academia usually offers**. Its approach focuses on the needs of the labour market, **innovation in pedagogy**, attention to entrepreneurship, and alignment with current significant topics, such as circular economy, future mobility, as well as alignment with current significant topics, such as circular economy, future mobility, green transformation.

For the **education institutions** involved in the programme, the added value is primarily **a result of cooperation**. AMIR allows to utilize synergy, taking advantage of each partner's specific expertise and specialisation. Involvement in the programme **increases visibility, exceeding what would be possible for a single university**, and improving access to the European academic field. Visibility is further increased by the **EIT Label**, which additionally reinforces the programme's reputation. This, together with the opportunity to study and intern in multiple European countries, bolsters AMIR's attractiveness to students.

HOW THE ACTIVITY HAS APPLIED KICS FINANCIAL SUSTAINABILITY PRINCIPLES

Until 2022, **EIT funding has been the primary funding source for the AMIR Master Programme**. In the first editions, the programme was supported by a scholarship from the University of Bordeaux. The situation changed significantly in 2022 with the award of the **Erasmus Mundus** grant, which provides a total of 3.9 million EUR over six years and allows the programme to be sustainable in that term. There are **no revenue streams** related to **sponsorship, services, or consulting**. Additional revenue is provided by tuition fees – 2,000 EUR annually for EU students and 4,000 EUR for non-EU students (Table 7). Presents the AMIR funding sources 2017-2022 in more detail.



As one of the interviewed stakeholders noted, this revenue source could be expanded by attracting more students who self-fund their education, in particular from non-EU countries. This would require using the EIT Label in promotional activities of AMIR outside of the EU, focusing on the programme’s excellence, track record, and the possibility of finding employment in Europe.

Table 7. AMIR funding sources

Revenue source (EURO)	2017	2018	2019	2020	2021	2022
EIT funding	108,647	146,960	432,279	552 620	554,763	473,624
Partner contributions, which include partnership fees, project co-funding, etc.	35,000	40,000	64,000	30,099	24,278	22,109
Public funding from national, regional, local or international bodies	13,000	13,000	13,000	0	0	650,000
Sponsorship	0	0	0	0	0	0
Education: tuition fees for AMIR Master Programme	ND	ND	84,000	160,000	176,000	154,000
Education: tuition fees for other studies, programmes, income from educational activities	0	0	0	0	0	0
Services & Consulting	0	0	0	0	0	0

Source: data provided by AMIR.

QUALITATIVE ASSESSMENT OF THE PROGRAMME AND ITS ACHIEVED IMPACT

QUALITATIVE ASSESSMENT OF THE ACTIVITY

The field of raw materials, circular economy, recycling, and materials life cycle assessment is becoming increasingly important as the world seeks to become more sustainable. **Experts** in this field play a crucial role in developing and implementing strategies and technologies that help to efficiently use and reuse materials throughout the entire value chain, from extraction and processing to end-of-life management. The **demand for these experts** is growing as the world looks for ways to reduce waste and improve resource efficiency. **The AMIR programme is responding to this need on a progressively increasing scale.**

Because the programme is being developed and created with the long term in mind, it is difficult to assess its effectiveness in the context of the industry, as it can take several years to create the infrastructure to



recycle a specific material³³. Therefore, the programme should be assessed primarily from **the perspective of the career paths of its graduates and AMIR programme students' evaluation**.

One of the key advantages of the programme is the **integration of innovation and entrepreneurship education throughout each semester** in different forms such as industry seminars, networking events, internships, and local incubator support. It is then extended further into the master thesis with a chapter on the reflections about entrepreneurship and innovation (in a broader sense on **societal and sustainability challenges**³⁴). This systematic approach facilitates students' development of a comprehensive understanding of the process of innovation and entrepreneurship. This knowledge can be then applied in different contexts, both academic and industrial. It also helps them to develop the skills necessary to turn their ideas into successful ventures and to better understand the commercial aspects of their field.

Data provided by AMIR indicates that **the programme is meeting its main goal: to provide the market with highly skilled professionals with good market and industry knowledge**. AMIR estimates that 95% of the 90% of graduates employed within 6 months of completing the programme are working in the raw materials sector³⁵. At the same time, among the 34 graduates from years 2019-2022 with whom the programme conducted a survey, 44.1% describe their field of activity as innovation in materials, and 41.2% as recycling and sustainability³⁶.

Most (85%) of the same graduates rated their **satisfaction with the programme highly or very highly** (with an average score of 4.26 on a 5-degree scale). Equally important, 94.1% of students felt that completing the programme had a positive impact on their careers³⁷. The high assessment of the positive impact on current or planned careers was also confirmed by interviews conducted with beneficiaries of the AMIR Programme³⁸.

The **strength** of this programme is also its **inclusiveness and diversity**. Thanks to the EIT RawMaterials and Erasmus Mundus grants, students from all over the world (including **RIS and Middle- and Low-Income Countries**³⁹) can participate, regardless of available financial resources. This is evident in the successive **growth of the programme** since the pilot AMIR Master Programme in 2017, both in terms of the number of academic partners (now including HEIs from RIS counties) and beneficiaries. Additionally, the programme

³³ Interview conducted with a representative of EIT RawMaterials, December 2022

³⁴ Of particular interest here is the Economic and Societal Issues in Mining and Recycling course for second year students, EIT RawMaterials, *AMIR Master Course Syllabus (2021-23 edition onwards), Detailed syllabi for the AMIR Year 2 partner universities (TU Darmstadt, Liège, TU Madrid)*. Internal material.

³⁵ Data provided with EIT RawMaterials Education and Innovation Director through email communication, January 2023

³⁶ 58.8% of the survey group is currently continuing their education in doctoral programmes, EIT RawMaterials, *Annex 29. Alumni Survey results*. Internal material

³⁷ EIT RawMaterials, Annex 29. Alumni Survey results. Internal material

³⁸ 4 interviews conducted with AMIR alumni and students, December 2022.

³⁹ Interview conducted with AMIR beneficiary, December 2022



helps in closing the gender gap in the raw materials industry, with women accounting for 46% of all existing programme beneficiaries and 39% of graduates as of 2022⁴⁰.

Lastly, one of the biggest advantages of the programme indicated by its beneficiaries is the **networking opportunities**. Students can participate in activities that allow them to make contacts both within EIT RawMaterials and the industry (i.e., Summer School, RACE). Combined with support in the form of *incubators, Jumpstarter* or *Lab2Market* beneficiaries of the programme receive extensive support in start-up idea development.

Table 8. presents an analysis of AMIR programmes strengths (internal and external), weaknesses, opportunities and threats (SWOTs).

Table 8. SWOT analysis of AMIR programme

Strengths	Weaknesses
<ul style="list-style-type: none"> ▪ Strong partnerships between programmes HEIs ▪ Network based on EIT RawMaterials ecosystem (networking and start-up events) ▪ Programme is accessible and affordable for students ▪ Focus on contemporary challenges in the fields of engineering, entrepreneurship and recycling ▪ A combination of entrepreneurship, innovation in recycling and engineering expertise ▪ A good balance between the particularity and universality of education ▪ Continuous strive to improve its design and offerings while being student-oriented ▪ Strong support offered to students in their development as start-uppers ▪ A wide range of EIT RawMaterials activities that offered, and participation encouraged ▪ Obligatory industrial internships 	<ul style="list-style-type: none"> ▪ Financial sustainability model is based on acquiring large grants ▪ Plans to maintain financial stability consider that students can pay tuition fees, but this may not be enough. ▪ No comprehensive database of information about the careers of graduates ▪ Difficulties in coordinating international students studying in six countries (insufficient communication tools and legal and administrative support) ▪ Insufficient number of industry partners to provide insights ▪ Insufficient involvement of entrepreneurs in shaping the educational process
Opportunities	Threats
<ul style="list-style-type: none"> ▪ Establishing a network of highly educated and innovative professionals within the raw materials area ▪ Expand to new geographic regions and industries with the addition of new partners to increase reach and impact ▪ Integration of new and emerging technologies into the programmes' offer ▪ Diversification of funding revenues to increase financial sustainability ▪ Additional services and resources offered to 	<ul style="list-style-type: none"> ▪ Not securing adequate funds for the programme to continue ▪ Global changes and developments that may reduce the influx and participation of students both from European and non-European countries. ▪ Rising competition from other similar programmes offering education and training opportunities for aspiring entrepreneurs.

⁴⁰ EIT RawMaterials, AMIR Master Programme, KPIs and outputs. Internal material.



programme participants to enhance their career prospects

Source: Ecorys.

ACHIEVED IMPACT

It is difficult to assess the programme's impact on the raw material industry, as the first cohort of programme students graduated in 2019. As of 2022, 82 people had completed the programme and 137 students participated since its first edition. As discussed in the section Achieved outputs and KPIs, programme has a record of **success for its students in start-up activities**.

In terms of broader impact, the programme provides **comprehensively educated alumni** to the industry, and responds to the rising demand for professionals in the circular economy sector, and as such contributes to the long-term sustainability of the raw materials life cycle by directly addressing the expert skills gap. The **skills** acquired through the programme are beneficial at **every stage of career development**, both in the industry, academia, SMEs and start-ups. Furthermore, the knowledge gained can be applied across multiple sectors.

Participants report that participation in the programme **increases their awareness of industry needs** and helps to **develop an entrepreneurial mindset**. This impact is supported by the **networking events**, which allow students to collaborate with students from other master programmes. This integrative approach, which includes HEI, industry and RTO partners, helps to broaden participants' perspectives on sustainability issues and develop innovative solutions.

Although currently there is **no system for tracking the careers of graduates**, a survey with programme alumni indicated that 56% (19 responses) of the respondents worked at a Higher Education Institution, 26% (9) at a Research or Technical Organisation, 24% (8) in a large company or SME, and 1 in a start-up. 59% (20) of the alumni who participated in the survey continued education at the PhD level⁴⁶. The qualitative gathered in the survey, as well as interviews conducted in this evaluation, indicate that AMIR graduates acknowledge the usefulness of what they learned in the programme for their careers.

'(...) the 2nd semester was mostly on recycling, and we also did a lot of sustainability (...). It wasn't really a topic that I've heard of before in my studies back home, (...) and now it's (...) what I'm doing, my job. I turned to be a sustainability engineer because of the programme.'

Alumni, AMIR Master Programme⁴¹

⁴¹ Interview conducted with AMIR alumni, December 2022.



LESSONS LEARNT AND GOOD PRACTICES

PRESENTATION OF LESSONS LEARNT FROM THE ACTIVITY IMPLEMENTATION

The AMIR programme stands out among other similar programmes and is valued by its participants for its combination of entrepreneurship, circular economy, and raw material processing expertise. Its success in fostering innovation and start-ups, and its growing enrolment and graduation numbers demonstrate its high impact. The programme's cohesion contributes to its effectiveness, and its design and implementation can serve as a source of good practices and lessons for other KIC's educational activities, especially in tertiary education.

The AMIR Programme found that making tuition fees simple, having diverse partners, and ensuring affordability and financial sustainability leads to increased accessibility, better solutions for beneficiaries, and a high impact. Good practices in designing a Master programme such as focusing on contemporary challenges, capitalizing on networks and EIT activities, and ensuring frequent and effective communication between partners demonstrated by the AMIR programme can be implemented into other programmes if some factors are taken into consideration.

Lesson learnt 1: Tuition fees

Simplifying tuition fees at participating education institutions increase the reach and accessibility of the programme.

The programme is based on the cooperation of six higher education institutions. Although each university operates under different local conditions, they have different rules regarding tuition, internships, etc. AMIR has unified the tuition fees for all students and the amount is a fixed number. The unified tuition fees are designed to ensure that all students receive the same quality of education regardless of which university they choose. Also, each university is paid as much as it is due, creating a sense of cohesion and trust between the six higher education institutions. This is especially important, given the fact that each university has different rules and regulations.

By having the same tuition fee, no student is disadvantaged when choosing a university, and everyone is guaranteed the same quality of education. Furthermore, this approach improves the perception of the programme as a whole by, ensuring that all partners and students are treated equally. This also ensures that students wishing to participate in the programme are guaranteed that, regardless of the educational path they choose, their tuition fees will not change. This makes the programme more accessible and increases its reach.

Lesson learnt 2: Cooperating with complementing academic partners

A variety of partners provides a range of possibilities best suited to the needs of the beneficiaries.



The diversity of AMIR's HEI partner specializations means that students can find the perfect programme to match their specific interests, enabling them to gain comprehensive knowledge and understanding within the common framework of circular economy and innovation. This provides students with the opportunity to gain in-depth STEM knowledge, as well as build individually relevant skills and expertise to apply to their own career paths. This requires research about potential partners, as well as about the expectations that the target group – in this case, potential students – might have.

Knowing prospective students' needs, interests and expectations can inform the design of the programme and the selection of partners. Therefore, it is essential to carry out an assessment of the target group and partner selection prior to the launch of the programme. This assessment should provide valuable insights into the types of skills that students require and the specializations that partners can provide, both of which should be considered when creating the programme. Furthermore, it is important to ensure that also the programme activities (such as entrepreneurial and networking events) are aligned with the interests of the target group, as well as with the specializations of the partners, in order to maximize the impact of the programme.

Lesson learnt 3: Ensuring programme sustainability and accessibility

The programme's high impact is guaranteed by making it both affordable and financially sustainable.

Currently, AMIR programme students receive scholarships either from EIT RawMaterials (AVSA grants) or the Erasmus Mundus programme that are sufficient to complete their education at one of the partner universities, regardless of the country in which they will be studying. Previously, students could also receive scholarships from the national funds of some partner HEIs. Thanks to this, foreign students or students without sufficient financial resources can participate in the programme.

Seeking diversified, yet beneficiary-oriented revenue sources increase the reach of the programme and therefore its impact. By becoming part of Erasmus Mundus, students are guaranteed stable scholarships to enable them to complete the programme, guaranteeing an adequate number of its graduates. This also has an impact on the perception of the programme as being focused on equality.

Lesson learnt 4: Expanding cooperation with private sector

Expanding cooperation with the industry would benefit both students and companies.

The expansion of cooperation with the private sector, particularly the raw materials industry, is necessary to offer tangible benefits for the participating companies and students. Such collaboration can provide access to talent and valuable insights for students to understand temporary challenges and opportunities in the field and switch between academic and private sectors more easily.



IDENTIFICATION OF GOOD PRACTICES FOR SHARING, INCLUDING KEY IMPLEMENTATION CONSIDERATIONS

Good practice 1: Designing a Master programme focused on contemporary challenges

Why: Designing a Master programme focused on contemporary challenges of sustainability, circular economy, and entrepreneurship provides students with relevant and practical education in areas of critical importance in today's world. This focus also helps to equip graduates with the knowledge and skills needed to tackle these pressing issues and drive positive change in society.

The AMIR programme is an educational proposition that is focused on contemporary needs and significant challenges – such as green transformation, recycling raw and advanced materials, circular economy, and supply chain resilience. Since the programme began, the importance of these issues for the EU has increased. As the AMIR case shows, a clear thematic focus was met with considerable interest and was appreciated by students. By adopting a multidisciplinary approach and partnership with leading HEIs, the programme overcomes the weaknesses of a traditional ‘silo’ structure of academic disciplines. Students have the added benefit of flexibility in choosing the institution at which they will specialise in a specific topic.

Designing the tertiary education programme focused on contemporary societal and economic challenges can have its chances for successful implementation increased if:

The programme has a good balance between its uniqueness and universality

When designing a Master programme around a particular challenge, it is essential to strike a balance between being too specific and too general. On the one hand, having a clear, specific focus (such as innovative recycling) will make it easier to communicate about the programme and select the appropriate disciplines and partners to address it. On the other hand, the educational offer must be broad enough to provide graduates with real-world career opportunities (e.g., in raw materials processing).

A programme that is too focused on a specific, narrow challenge will likely have limited career prospects for its graduates, while one that is too broad may not effectively address the challenge at hand. Finding the right balance will ensure that the programme is both relevant and useful.

The programme should have a clear focus on the challenge it wishes to address

When designing a Master programme, it is crucial to have a clear focus on the challenge that the programme will address. This clarity will facilitate communication about the programme and make it easier to select the appropriate disciplines and partners. A well-defined focus will help to attract students and partners who are passionate about addressing the particular challenge, and will make it easier to communicate the purpose and value of the programme to stakeholders and beneficiaries.



The programme should provide a broad educational offer to provide its graduates with career opportunities.

While it is important to have a clear focus on the challenge, the educational offer must be broad enough to provide graduates with real-world career opportunities. This means that the programme must cover a range of relevant subjects and skill development opportunities so that graduates will be equipped with the knowledge and skills they need to succeed in their careers. A programme that is too narrowly focused on a specific challenge may limit the career prospects of its graduates, while one that is too broad may not effectively address the issue. Finding the right balance will ensure that graduates are well-prepared for careers in a range of fields related to the challenge.

Good practice 2: Capitalising on networks and EIT activities

Why: providing students with access to valuable resources and networks that can support their entrepreneurial journey and help them build successful start-ups.

The programme's students participate in activities organized by AMIR and EIT RawMaterials to enhance their potential as entrepreneurs and assist them in creating their own start-ups and build a network of students and the industry. It is a good practice to organise a wide variety of events, promote them to students, and make it possible for them to attend so that students can build a network and receive significant support in building their start-ups.

To effectively facilitate participation in EIT networks and activities, it is important to consider:

The programme should promote extracurricular activities and networking events

To effectively benefit from EIT networks and activities, it is important to promote these activities to students in a way that efficiently reaches them and encourages their participation. This can include advertising the events through various channels (e.g., email, brochures, social media, online educational platforms), as well as presenting the value of participation (e.g., meetings with programme graduates, EIT Alumni).

The activities should be well-organised and accessible

It is important to ensure that the events are well-organized, accessible, and relevant to the students and their interests. Of particular importance is to make the EIT network activities financially accessible in order to ensure that all students can attend and benefit from them, regardless of their resources. This can be achieved through several means, such as offering scholarships or grants to cover travel and other expenses related to attending the events or partnering with local organizations and businesses to provide financial support. This way the programme can ensure that all students have equal opportunities to benefit from the valuable resources and networks available through the EIT network and is possible to increase student participation.



Good practice 3: Ensure frequent and smooth communication

Why: it helps foster a positive and productive learning environment, improves student engagement and satisfaction, prevents misunderstandings, and ensures all stakeholders have a clear understanding of expectations, deadlines, and responsibilities.

Coordinating the efforts of multiple partners and stakeholders in a programme of this scale can be challenging. Good practice involves regular bi-weekly partner meetings in the AMIR programme to ensure smooth communication and coordination of work. The success of the programme, evidenced by its multiple editions and a growing number of partners and participants, highlights the importance of regular communication between partners and effective management.

To ensure smooth communication between partners and stakeholders in a programme of this scale, it is important to consider implementing several strategies and practices, such as:

The programme may consider formalizing cooperation through Work Package Agreements

To ensure practical cooperation between partners, it is important to formalize the partnership into Work Package Agreements, as is done in the AMIR programme. These agreements may for example outline the activities of each partner and provide a clear understanding of their respective roles and responsibilities. Work Package Optimization meetings can then be held during implementation to discuss and optimize the agreements as needed.

The programme should facilitate frequent communication and meetings

In addition to formal agreements, it is also important for partners to communicate frequently on a day-to-day basis. This can be achieved through regular meetings with representatives of all partners responsible for management and finances. These meetings provide an opportunity for partners to discuss progress, address any concerns, and work towards a shared understanding of the goals and objectives of the programme.

PRESENTATION OF POTENTIAL FOR REPLICATION AND SCALING UP (INCLUDING IDENTIFICATION OF RELEVANT TARGET GROUPS AND SCALE OF FUNDING)

The most significant feature of the AMIR programme is its "**T-shape**" approach. In adopting it, AMIR Programme aims to produce experts who not only have specialized knowledge in their field but also have a well-rounded understanding of other areas and can work collaboratively with individuals from different disciplines, which is important when creating innovative solutions to achieve sustainability in the field of raw materials.

The "**T-shaped**" approach to education is a highly transferrable idea, already integrated into other KIC's educational activities, but the AMIR Programme is an excellent example of how to successfully implement



this idea into tertiary education. The combination of a STEM education with a continuous path of entrepreneurial education, networking opportunities, and support for star-ups, along with industry partnerships, can be highly effective in developing a **strong and sustainable entrepreneurial ecosystem**. **This holistic approach can help to create a pipeline of well-rounded, innovative entrepreneurs who are well-prepared to start and grow successful businesses.**

This kind of practical application of the “T-shape” approach can be replicated in various other master's or doctoral programmes, when some of the conditions are met:

Key **conditions for successful replication** to other KICs or institutions:

- A strong ecosystem consisting of HEI, industry and RTO partners must be built and maintained.
- To attract new partners, the well-roundedness of graduates' education should be emphasized. This will draw attention to providing the market with new talents.
- Within this ecosystem, mutual obligations should be established. Constant, open communication is necessary.
- Sustainable funding options for students' scholarships should be explored.
- Participation in various activities and events should be promoted. The programme's activities should be adapted to participant expectations.
- An evaluation framework (including beneficiaries' and partners' point of view) should be developed to measure the programme's impact, and so that any challenges can be responded to properly and quickly.

The programme itself has a potential for scaling up, for example, by attracting more industry partners willing to provide internships and seminars and co-develop the study programme and increasing the number of partner HEIs. Another possible avenue is increased promotion of the programme to students from non-European countries. Additionally, strengthening the existing cooperation with other EIT RawMaterials Master programmes can help increase the programme's reach. However, since one of the programme's greatest strengths is its accessibility through the distribution of scholarships to students, for the programme to increase its reach and maintain its goals and structure, it is necessary to obtain continuous funding.

Key **conditions for successful scaling-up** of the programme:

A source of additional funding should be established to meet the increased demands of the programme; i.e. a bigger student cohort, as the programme's inclusiveness and financial accessibility are one of its strengths.



A well-functioning and accessible online information platform should be established for the programme students, given its scale and international nature.

The programme should be promoted to non-European students, pointing out both the practical nature of entrepreneurial and engineering courses, opportunities for the development of start-up ideas, and the quality of education confirmed by the EIT-Label.

CONCLUSIONS

The AMIR programme is unique in terms of its proposition and structure. Selected as one of the top 10 Unique Study Programmes by the European Commission, it is a strong illustration of the knowledge triangle integration. As evidenced by considerable, continued interest from students, the decision to approach programme design by focusing on significant contemporary challenges was right, and the programme is becoming recognizable and desirable for candidates globally.

Importantly, the strong academic offer of HEI institutions participating in the programme is supplemented by EIT RawMaterials, which provides a practical, applied perspective, access to multiple activities, networking and entrepreneurial potential. Thanks to industry and research partnerships, students are provided with valuable practical experience and exposure to the work environment in their field of study, supporting the T-shape approach to learning outcomes.

As the interviews have shown, alumni of AMIR indeed gain useful competencies and knowledge, sought for in the labour market. During the courses and through the EIT RawMaterials incubator support services (Lab2 market, Accelerator programme), students gain knowledge on entrepreneurship and innovation, supporting them in becoming entrepreneurs and creating start-up ideas.

The programme's implementation through several stages since 2017 shows considerable determination for development, with the partnership structure evolving, and significant support to sustainability by becoming an Erasmus Mundus programme. Nevertheless, EIT RawMaterials and the EIT-Label are important elements of the AMIR programme, providing networking and reputational benefits.