TREND & INNOVATION NETWORK 3: SMART & ADVANCED MATERIALS

D.T2.2.4 - A report on 10 TTTDMs for Smart & Advanced Materials

Version 4.0

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Authors: Laura Salomon | Fraunhofer IWU
Mathilde Besnard & Sarah Hedden | MIND CONSULT & RESEARCH GmbH

Document Control

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RE	Restricted to a group specified by the consortium	
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This project is co-financed by the European Regional Development Fund through Interreg Central Europe.

Executive Summary

Project Overview

CEUP 2030 aims to generate stable innovation networks which foster better understanding on **C**entral **E**urope Advanced **M**anufacturing and **I**ndustry **4.0** ("**CAMI4.0**") topics, to generate improved knowledge resource exchange on these technologies leading to an upgraded framework for policy-making and implementation.
Ultimately CEUP 2030 creates and tests a common method to promote improved knowledge dissemination to policy-making stakeholders using a collaborative exchange framework based in physical and digital-methods. These methods and the technology show-cases disseminated within these method structures are harvested from existing, high-quality innovation know-how in the CE area.
The project focuses on:

- Identifying the highest-quality innovation know-how in the CE Area, on the CAMI4.0 Topics.
- Enhancing skills capabilities and knowledge of people in charge of local, regional, and (trans)national RTI Policies, associated to the CAMI4.0 Topics.
- Creating a sustainable structure for awareness-raising and shared-sustainable RTI knowledge resource use to enhance policy decision support.
- Anticipating and fast-tracking policy / strategy policy pilot actions to promote a joint RIS3 for CAMI4.0 Excellence in CE/EU.

Work Package and Activity Overview

The overall objective of WPT2 is to upgrade and establish strong partnerships around the 4 main CAMI4.0 topics in order to raise awareness and ensure a shared sustainable responsibility on using RTI knowledge resources in CE/EU for enhancing policy decision support. This will be pursued by establishing sustainable structures of stakeholders called Trend Innovation Networks (TIN) as well as practicable, efficient policy tools, the so-called Policy Intelligence Dashboard (PID). Both those instruments will be exploited by the partners to select and channel appropriate decision-relevant information out of the daily big data cloud, assess it and provide understandable knowledge in a compact and high-quality format.

Practically speaking, in each partner region a TIN will be established and it will work on future foresight, technology trend monitoring, scouting. These activities will also feed the PID with the gained data to produce Tech Radars and other insights able to support decision making.

The specific activity which is of relevance for this document is Activity A.T2.2, which is related to the establishment, development and upgrade of Trend and Innovation Networks (TINs) in CE regions.

Scope of Document & Deliverable Summary

This report provides a summary of the results from all 10 TTTDMs (TINs Tech and Trend Dialogue Meetings) about the CAMI4.0 topic "Smart and Advanced Materials". In addition, this document provides an overview about the way these meetings were held and the methodology that was used to complete the Deliverable D. T2.2.4.

Audience

This document is addressed to all the project partners that will be involved in the organisation of TTTDM, following the suggested methodology and exploiting the results of these workshops to further contribute to the project development.

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Change Control Procedure & Structure

The Deliverable Responsible, Fraunhofer IWU, created this result report which is hosted on the Project's common repository in the appropriately named deliverable folder. The document is under project deliverable change control protocols whereby Partners are requested to give feedback on the Draft Version according to the timing proposed in the final section of this document. Feedbacks will be incorporated and the Final Version will be issued by Fraunhofer IWU.

At any time, partners that believe a project methodology should change, should submit the request to the Deliverable Responsible and the Work Package Leader (IWU/PP4) to consolidate feedback from other partners, and then further integrate and disseminate the final agreed changes. A new version of the document should be created and recorded in the document's "Document History" table.

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Abbreviations

Abbreviation	Explanation
AF	Application Form
IPS	Intelligent Production Systems
AI	Artificial Intelligence
R&A	Robotics and Automation
CAMI4.0	Central European Advance Manufacturing and Industry 4.0
PLL	Policy Learning Lab
PP	Project Partner
RIS3	Regional Innovation Strategy for Smart Specialisation
S3	Smart Specialisation Strategy
S&A Materials	Smart & Advanced Materials
TIN	Trend & Innovation Networks
IWU	Fraunhofer Institute of Machine Tools and Forming Technology
KIT	Karlsruhe Institute of Technology
PBN	Pannon Business Network Associations
PTP	Pomurje Technology Park
HAMAG	Croatian Agency for SMEs, Innovations and Investments
AFIL	Lombardy Intelligent Factory Association
SIIT	Intelligent Integrated Systems Technology SIIT
PIA	Association Industry 4.0 Austria
KPT	Krakow Technology Park
PRO	PROFACTOR GmbH
TTTDM	TIN Tech and Trend Dialogue Meetings

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1. Introduction

The purpose of this report is to communicate the significant results of the 10 TTTDM methodology held on the CAMI 4.0 Topic "Smart and Advanced Materials" under the lead of Fraunhofer IWU ("IWU"). Therefore, this report showcases the key outcomes and lessons learned from the TTTDM on Smart Materials. This report has, as a final objective, to provide insights for the partners to build upon the TTTDM result the Common Policy Use Case.

1.1. Background

1.1.1. On the project CEUP2030

The European Union is the world's biggest exporter of manufactured goods, and is a global market leader for high-quality products. Central Europe's manufacturing sector is a fundamental component of the EU economy with a large amount of high-value innovation know-how in the area of advanced manufacturing and industry 4.0. These two areas are critical for maintaining Central Europe's competitive edge and high employment rate in this economic sector. However, organisations within this eco-system lack sufficient cooperation & structure to really add-value; limiting the competitive potential of connected regions.

CEUP 2030 aims to generate stable innovation networks which foster better understanding on **C**entral Europe **A**dvanced **M**anufacturing and **I**ndustry **4.0** ("**CAMI4.0**") topics, to generate improved knowledge and resource exchange on these technologies leading to an upgraded framework for policy-making and implementation. The purpose of CEUP 2030 is to improve policy-making, by exploiting and upstreaming available outputs and results from excellent work delivered in the programming period 2014 to 2020, to create new recommendations for policies and strategies to enhance Central Europe's Advanced Manufacturing and Industry 4.0 capacities.

1.1.2. On TINs

1.1.2.1. Description and Goals

The **Trend & Innovation Networks (TINs) are communities of stakeholders** established/anchored around the 4 main topics of CAMI4.0: Intelligent Production Systems, Automation & Robotics, Smart Materials and Artificial Intelligence (Refer to D.T1.1.1 and D.T.1.1.2 for detailed description of CAMI4.0 topics).

Each PP established a TIN for each CAMI 4.0 area, inviting representatives of the triple-helix who **discussed and shared trend and innovation foresights** on the targeted topics. Those communities built on the stakeholders involved in Policy Learning Labs (PLL) in WPT1 and were enriched with key experts identified by each partner.

Although TINs have been arranged as a digital community, 40 regional meetings (**TTTDM - TINs Tech Trend dialogue meetings**) were organised fostering interregional connection and with the aim to build on the inputs collected during PLL to generate relevant inputs for a future robust policy implementation in the form of technical reports on technologies trend for WPT3. Accordingly, Partners (PPs) organised 4 workshops focused on TINs topic and/or sub-topics starting from November 2020 and by November 2021. Due to the activities slow-down caused by COVID-19 consequences these meetings have been organised in a longer timeframe and held in a virtual form.

Besides their regional configuration, TINs also had an interregional dimension thanks to action of PPs that guaranteed connections among the different network exploiting the

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synergies that emerged during TINs development. In particular, PPs contributed and fostered the identification and development of use-cases in each network that can be concretely implemented in flagship projects involving partners from different regions, either PPs or their stakeholders. By the end of CEUP2030, each TIN guaranteed the generation of 5 use-cases contributing to increase the amount of funds leveraged based on project achievements.

As an output of CEUP2030, Trend and Innovation Networks for CAMI4.0 strongly contributed in the generation of stable innovation networks which were designed to foster a better understanding, generate improved knowledge and exchange on new technologies relevant for Central Europe Advanced Manufacturing and Industry 4.0 and raise awareness on RTI knowledge resources to enhance policy decision making. Accordingly, the methodology and the processes of the TINs enabled for one side the exchange of good practices and available knowledge among stakeholders at regional and interregional level and on the other side the generation of professional inputs for future policies improvement.

1.1.2.2. Specific objectives and outputs

CEUP2030 Trend and Innovation Networks are one of the main outputs of the project and they are meant to:

- Generate improved knowledge and exchange on new technologies relevant for Central Europe Advanced Manufacturing and Industry 4.0;
- Set-up stable innovation networks of stakeholders, where to generate new project ideas and foster interregional cooperation
- Enhance policy making fostering a better understanding of stakeholders' needs and related priorities as well as highlighting existing knowledge gaps of the institutions

In line with these strategic goals and with expected project results, a set of detailed objectives to be pursued by each TIN has been defined, including concrete activities to be implemented by each partner, as well as more strategic actions to be conducted in cooperation with all the partnerships:

> **Trend and Innovation Network Workshops**

To foster the discussion on trend and innovation foresight on the targeted CAMI4.0 topics, **40 TTTDM - TIN Tech Trend Dialogue meetings will be organised by CEUP2030 partners involving the regional stakeholders identified in the community**. TTTDM represent the main instruments that TINs should exploit to deliver the outcomes expected and meet the objectives set. TTTDM are envisaged as workshops that will be organised not only with the aim to discuss technical contents and foster the matchmaking among participants, but they will also address key challenges and barriers that might be overcome with the support of institutions. Indeed, the targeted audience will include participants from the triple-helix to be engaged in the discussion, with the aim to generate inspiring content both for the definition of new flagships projects as well as for the definition of strategic policy guidelines to be transferred to policy makers at different levels.

A dedicated paragraph (4.3. TTTDM Methodology) has been elaborated to describe in details the requirements connected to these meetings, complemented with a proposal of methodology to be implemented by partners in the organisation of the workshops.

> **Roadmaps Tips**

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Leveraging on the outcomes of TTTDM, partners should elaborate a list of recommendations for policy makers, to be considered in WPT3 and eventually further developed during RIS3 Round Table. These policy recommendations could be elaborated from the preliminary inputs derived from PLL as well as from the discussions that are engaged during the TTTDM. More in details, they should be finalised to elaborate suggestions for improving industrial policies, based on the main needs and priorities highlighted by stakeholders participating in TINs and related to the development and uptake of specific technologies in the targeted CAMI4.0 area.

- **Use-cases and Flagship projects**

Project partners will have the opportunities to exploit TINs and TTTDM to foster the identification and development of use-cases that can be turned into flagship projects involving CEUP2030 partners and or their stakeholders. Each TIN, based on the topics and sub-topics identified and building on the competences and knowledge available in the participating regions, is expected to identify 5 use-cases in alignment with what has been pre-defined in WP1 Harvesting for the different CAMI4.0 topics.

Interregional cooperation and connections among the regional communities have to be ensured by project partners involved in the TINs, making sure that their stakeholders can grasp all the opportunities coming from the TINs and more in particular ensuring their participation in relevant use-cases or flagship projects. To support this action, partners can also constantly look for funding opportunities coming from interregional or EU programmes. To this end, open calls connected to EU projects as well as new INTERREG calls can be considered.

- **Community Building**

While establishing and reinforcing the connection among the ecosystems in the different regions, project partners will set-up cooperation mechanism to ensure long term sustainability of TINs. This will allow to continue activities beyond the project lifetime focusing on the implementation of flagship projects and fostering the cooperation also at institutional level, supporting policy maker in improving existing schemes and eventually designing new cooperation opportunities.

1.1.3. On the CAMI Topic Smart and Advanced Materials

Smart and Advanced Materials, also called intelligent or responsive materials, refers to designed materials that have one or more properties that can be significantly changed in a controlled fashion by external stimuli, such as stress, moisture, electric or magnetic fields, light, temperature, pH, or chemical compounds. Smart materials are the basis of many applications, including sensors and actuators, or artificial muscles, particularly as electroactive polymers (EAPs). Smart materials are understood to show interaction with the environment. They are innovative and functional materials for industry 4.0.

This TIN in CEUP 2030 has 4 specific sub-topics in the following areas:

- **Smart structures & Systems**
- **Process-related sensor technology**
- **Smart Materials network**
- **Functional printing**

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1.2. Key Definitions and Concepts

CAMI4.0: This acronym stands for "Central Europe Advanced Manufacturing and Industry 4.0" and is a short hand reference for all of the thematic topics and sub-topics which the Partnership have used to frame the technology / content discussions within the project.

Trend & Innovation Networks: The Trend & Innovation Networks (TINs) are thematically focused working groups, comprised of the Partners and their key regional stakeholders. Together this innovation network is used to gather foresight on challenges and opportunities which emerge in the chosen technology areas, and across the territorial area's manufacturing sector. Together this network should be ideating on, developing, and then implementing several models to promote transnational cooperation (in the form of use-cases, see below).

Policy Instruments: Policy Instruments are the subsidy and or support tools and structures which exist to promote advanced manufacturing or industry 4.0. This can be a funding scheme, a subsidized service, equipment or infrastructure finance program, or another form of support tool looking to promote advanced manufacturing. These can exist at different territorial levels, but are usually promoted by a government / policy making organization, or an organization which has a mandate to deliver an instrument

Strategy Implementation Blueprint: This is a named output of the project, also called "CEUP 2030 Strategy Upgrade and Boost" (O.T1.2), which connects lessons learnt from stakeholder engagement discussions with a joint strategy built from PP experiences and insight across other initiatives (projects / regional actions). This strategy will be supported by 10 practical use-cases (see: policy instrument use cases/ use case portfolio)

Policy Instrument Use-Cases & the Use-Case Portfolio: The 10 Use Cases (10 portfolios, 4 actions/PP), are the output of D.T1.3.3 **(by February 2021),** and should be good examples of results or experiences from each PPs in this programming period, which showcase how to use these instruments and in an understandable, how policy instruments create specific positive motion to support organizations in engaging with the CAMI4.0 topics.

RIS3 Alignment Instrument Pilot Projects: By WPT3 PPs should have evidence of starting/enabling 20 new regional RIS3 Alignment Instrument Pilot Projects (2/PP) **(by September 2021),** where they aim to showcase how specific policy instrument action can improve regional S3 support for chosen CAMI4.0 topics. These pilot projects should be built from the "Policy Instrument Use Cases" identified at the end of WPT1. They also are the project's primary tool to demonstrate sustainability of idea, and ongoing monitoring for the achievement of the CAMI4.0 Vision & Objectives.

Common Policy Use Cases: In WPT2 and WPT3 emerges the idea of the coordinated "alignment" of policy instruments. This is a key area of discussion which should occur between PPs (in CAMI4.0 Working Groups, aka TINs in WPT2) and their stakeholders (In RIS3 Round Tables, in WPT3). By the end of the project PPs operating across the 4 CAMI4.0 Topics create 4 common policy use-cases **(By February 2022),** where the stakeholders involved in each CAMI4.0 working group (TIN) agree a plan to align activities for the coming programming period.

Policy Implementation Framework: This is a named project output, also called "CEUP 2030 Policy Framework – Synergizing CE/EU Policies and Strategies for CAMI4.0 Excellence" (O.T3.2), which is the final strategic output of the project. It presents a combined view of the project's results – specifically a vision and objectives for each CAMI4.0 topic, with a

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signed capitalization agenda showing the support of a diverse group of stakeholders (including Policy- Relevant stakeholders) and implemented through the formation and initiation of RIS3 Alignment Instrument Pilot Projects (See definition above). This should be achieved by February 2022 and must showcase the pilot projects and common policy use-cases.

1.3. Purpose of the document

Each PP organized a TTTDM on Smart & Advanced Materials TIN, according to its role, with the specific objective to collect regional expertise and capabilities on this topic, to foster the creation of a regional community and to share best practices. This document reports on the 10 TTTDM held by the partners on Smart Materials and provide insights on how to build upon these 10 TTTDM.

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2. Objectives and Responsibilities

The Trend & Innovation Networks were organised as digital communities of stakeholders anchored around the 4 main topics of CAMI4.0: Intelligent Production Systems, Automation & Robotics, Smart Materials and Artificial Intelligence. These topics have been selected in the framework of CEUP2030 project, since they have been recognised as the most strategic topics to be developed in the Central Europe area to maintain the competitiveness of Advanced Manufacturing stakeholders and further develop their knowledge and competences. More in details, each CAMI4.0 topic has also been specified in term of sub-topics to clearly identify the contents to be discussed and developed within the network.

This report focuses mainly on the topic "Smart & Advanced Materials" (S&A Materials), which is led by the CEUP2030 partner IWU - Fraunhofer. TIN Leaders are responsible to guide the definition of the TIN specific objectives as well as supervise actions implemented by the group of partners involved ensuring that, by the end of the project, TINs goals and the targets have been met.

CEUP2030 partners all contributed to the development of TINs by establishing a regional network in the different CAMI 4.0 areas, inviting representatives of the triple-helix who contributed discussing and sharing trend and innovation foresights on the targeted topics.

2.1. Smart and Advanced Materials Objectives

Specific objective regarding the Topic of Intelligence Production Systems have been defined in the table below:

Table 1. Smart & Advanced Materials Objectives (Source: DT1.3.2, CEUP2030, 2020)

Number	Objective Name	Objective Description
1	Networking	Connect the partners via the TIN to broaden the scope of reach and promote future development of smart materials topics. Use the competencies of existing networks in the partnership.
2	Project Proposals	Promote the discussion about the possibilities for concrete project work between the PP or stakeholder of the TIN.
3	Coordinate use case definition and actions	Refine technological best practices to inform and raise awareness among the different stakeholder groups (policy makers, business, research institutions).
4	Project related objectives	Deliver 10 workshops as required in CEUP2030 and provide suggestions for the PID, create models for technical objectives delivery and a strategy document as well as lessons learnt.

2.2. Stakeholders

2.2.1. Partners

With regards to this activity, all partners took a role in delivering an expert workshop associated to Smart and Advanced Materials.

Table 2. Partners of CEUP2030 (Source: Author generated, CEUP2030, 2021)

Name of the partner	Abbreviation	Country
1- KRAKOWSKI PARK TECHNOLOG ICZNY	KPT	Poland

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2- PROFACTOR GmbH	PRO	Austria
3 - Verein Industrie 4.0 Österreich	PIA	Austria
4- Fraunhofer Gesellschaft zur Förderung der angewandte n Forschung e.V. für das Fraunhofer Institut für Werkzeugmaschinen und Umformtechnik (IWU)	IWU	Germany
5- Karlsruher Institut für Technologie	KIT	Germany
6- Associazione Fabbrica Intelligente Lombardia	AFIL	Italy
7 - SIIT S.c.p.a. Sistemi Intelligenti Integrati Tecnologie	SIIT	Italy
8 - Pomurski tehnološki park	PTP	Slovenia
9 - Pannon Gazdasági Hálózat Egyesület	PBN	Hungary
10 - Hrvatska agencija za malo gospodarstv o, inovacije i investicije	HAMAG	Croatia

2.2.1. Partners' Role and activities

According to the definitions developed in T2.2 and considering the heterogeneity of CEUP2030 consortium as well as the regional priorities, partners are classified with different roles in the TINs based on their competences, knowledge, and potential stakeholders' interest:

- **Leader**: partner in charge of guiding the development of the TIN, making sure that all the partners involved contribute to the definition of objectives and strategy and comply with the requirements. Leaders will take care of ensuring alignment among regional communities, organising periodic meetings and making sure synergies are properly exploited. Finally, the leader of the TIN will also be the responsible of writing the TIN deliverable reporting on the meetings organised by the group and the main achievements.
- **Core**: partners in this role are considered the main contributors to the TIN contents. They have well developed knowledge and competences in the field and through the organisation of TTTDM they are going to present regional best practices as well as building the basis for interesting use-cases to be developed with other partners or their stakeholders.
- **Learner**: partners who do not have a grounded experience in the field, though the field itself might be one that is of significance to the strategic priority of the region. Learners can therefore also leverage the expertise of other PPs and TINs of other regions to improve their competences and knowledge, exchanging with leader and core partners and eventually organising meetings and raising their overall competence with their support.

Furthermore, the Partners took the following roles, detailed in Table 3, within the Smart and Advanced Materials TIN working group structure. These roles have been chosen to optimally address technology and content relevant competencies within the CEUP 2030 partnership:

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Table 3. Smart & Advanced Materials TIN Structure (Source: DT1.3.2, CEUP2030, 2021).

Working Group Members	
Leader	**Fraunhofer Institute for Machine Tools and Forming Technology (IWU)**
Core Member	**Learner**
☒ Krakow Technology Park (KPT) ☒ Lombardy Intelligent Factory Association (AFIL) ☒ Intelligent Integrated Systems Technology (SIIT)	☒ Croatian Agency for SMEs, Innovations and Investments (HAMAG) ☒ Pomurje Technology Park (PTP) ☒ PROFACTOR (PRO) ☒ Karlsruhe Institute of Technology (KIT) ☒ Associated Industry 4.0 Austria (PIA) ☒ Pannon Business Network Association (PBN)

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2.2.2. Participants

The graph below shows the number of participants per partners who attended the expert workshops.

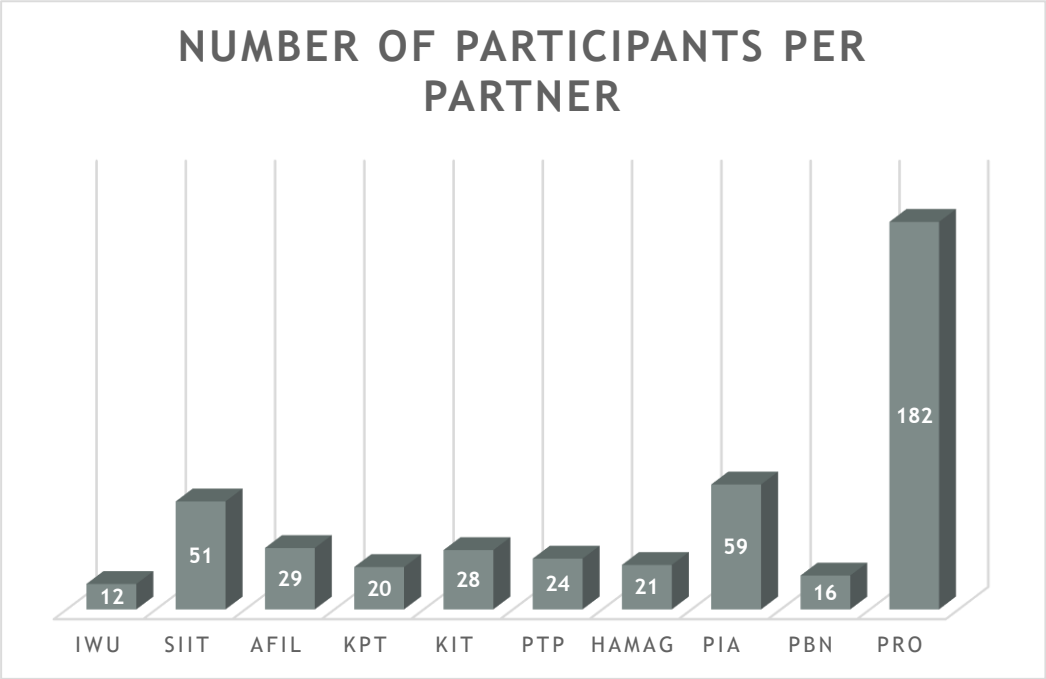

Figure 1 - Number of TTTDM S&A Materials participants per partner

(Source: Author generated, CEUP2030, 2021)

The graph below showcases the repartition of target groups per partners.

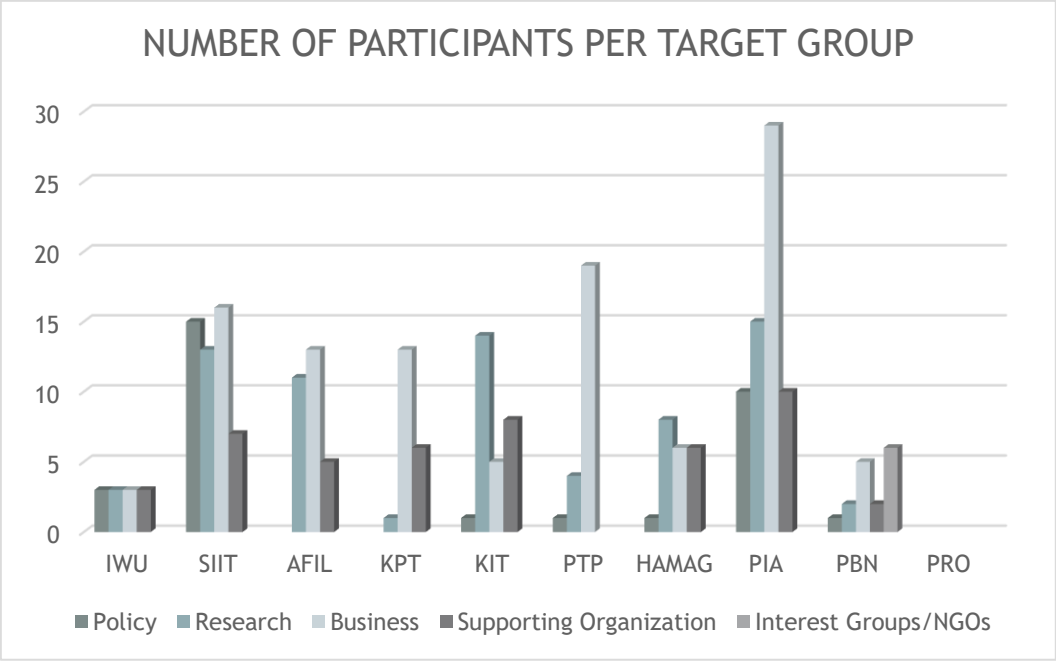

Figure 2 - Number of TTTDM S&A Materials participants per target group per partner

(Source: Author generated, CEUP2030, 2021)

The graph below provides an overview of the target's groups represented:

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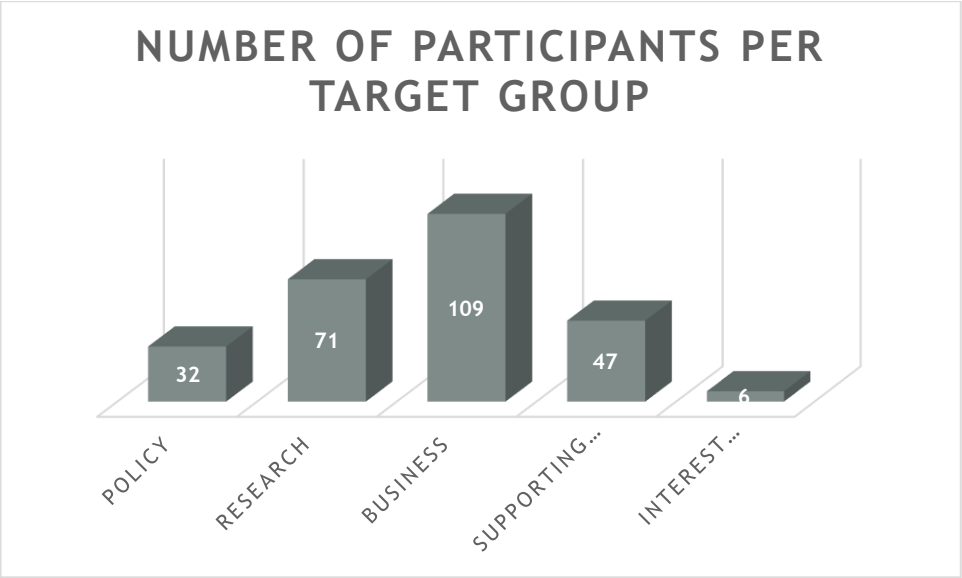

Figure 3 – Total Number of TTTDM S&A Materials participants per target groups (Source: Author generated, CEUP2030, 2021)

Most of the participants were represented by businesses and research organizations dealing with S&A Materials solutions and innovations. This was a positive result considering the objective of TTTDMs, i.e., to build and strengthen a stable network of interested stakeholders working on the topic. The industrial presence was also strengthened by business support organizations and Policy makers who will share the outcomes to their associates, increasing the overall impact of TTTDMs also externally to participating stakeholders.

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3. Methodology

This section provides insights on how the results and analysis of the TTTDM were pulled out from raw data.

3.1. Data Collection

Harvesting from the cross-section of projects was a key enabling activity of CEUP 2030, to which every PP was asked to contribute. It was important that PPs worked to review the organisation's past projects with the goal to prioritise the capitalization of knowledge and know-how gained from a cross-section of good practice projects. Partners were asked to review their Result Portfolio and filter for results which would add value to CAMI4.0. This review and filtration of results, with the purpose of capitalising knowledge within CEUP 2030 is the associated definition of the term "harvest".

The PPs have provided good practices as an inspiration for the TINs that have been collected in D.T2.1.2., where a complete overview of partners contributions is available as well as a detailed analysis of the results.
In the process of creating this document, the harvested good practices were analysed and inspiring points were highlighted to define guidance for TINs set-up ad TINs orchestration that will be presented in the following table:

Table 4. TIN Structure (Source : DT2.1.2, CEUP2030, 2020)

TINs set-up	TINs orchestration (organisation of TTTDM)
• Mixture of a top down and a bottom-up approach when setting TINs up • Ensure long term sustainability defining a clear plan for the next 2-3 years • Define the role of each partner in contributing to the different TINs • Plan regular online meetings to connect regional networks at interregional level • Set-up and continuous update of stakeholders' database to monitor their involvement in the networks	• Identify wide target groups and facilitate the long-term participation of stakeholders in this network • Allow flexibility in the workshop structure • Focus on a specific topic or sub-topic • Include different perspectives to involve different stakeholders having different interest • TTTDM structure should have different sessions organised to achieve diverse objective (*i.e., technical panel to present specific applications + round table with experts to address challenges and foster the interactions among different type of stakeholders + matchmaking session to favour the establishment of fruitful collaborations*)

3.2. Implementation

As anticipated in the objective sections, 10 TTTDM for S&A Materials (40 in total for all 4 CAMI4.0 topics) area have been organised. The meetings were expected to be organised targeting regional stakeholders.

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All the TTTDMs despite the topic they addressed had to follow the same structure. Therefore, three main objectives were raised during the report on the TTTDM on AI: Awareness Raising, Knowledge Exchange and Cooperation Enhancement.

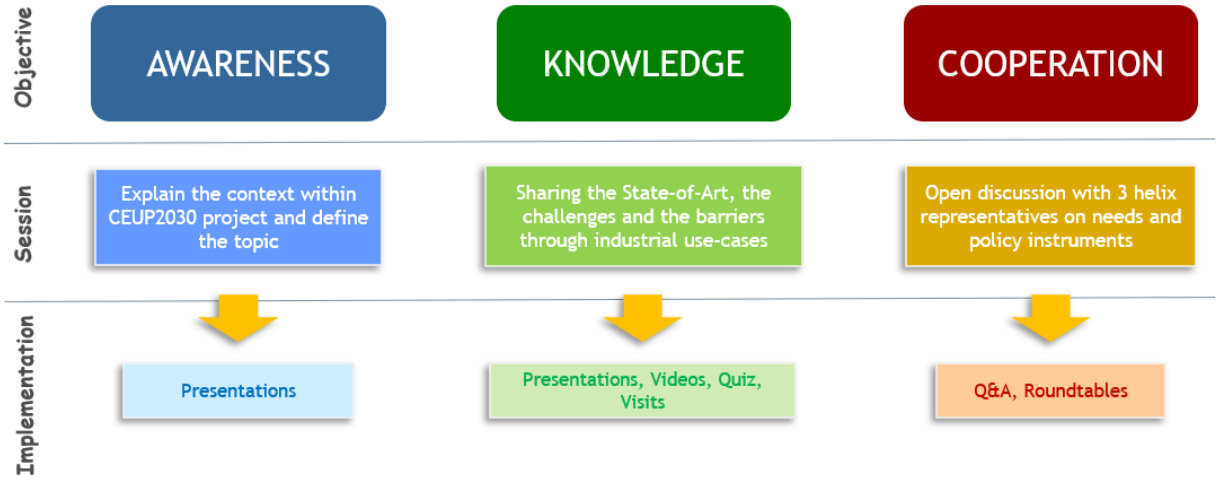
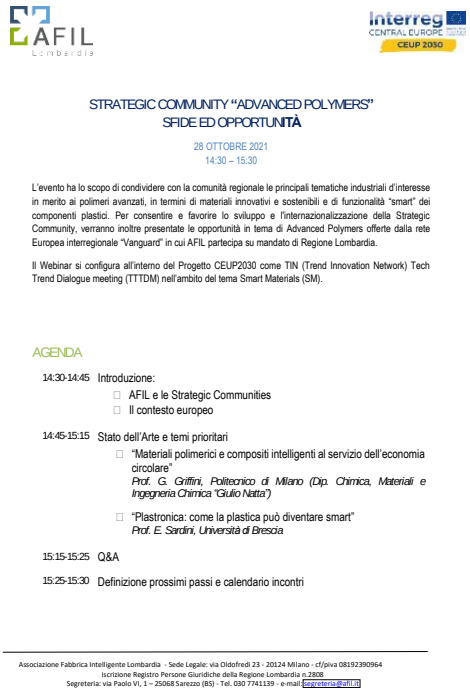


Figure 4: General structure of AI TTTDMs (Source: Report on AI TTTDM, CEUP2030, 2021)

The partners designed their events to meet these three objectives, and built agendas which facilitated both detailed and strategic/general overviews about S&A Materials. All partners had to issue an agenda regarding their TTTDM:

Figure 5 - Agenda of HAMAG

(Source: AFIL, CEUP2030, 2021)



STRATEGIC COMMUNITY "ADVANCED POLYMERS"
SFIDE ED OPPORTUNITÀ

28 OTTOBRE 2021
14:30 – 15:30

L'evento ha lo scopo di condividere con la comunità regionale le principali tematiche industriali d'interesse in merito ai polimeri avanzati, in termini di materiali innovativi e sostenibili e di funzionalità "smart" dei componenti plastici. Per consentire e favorire lo sviluppo e l'internazionalizzazione della Strategic Community, verranno inoltre presentate le opportunità in tema di Advanced Polymers offerte dalla rete Europea interregionale "Vanguard" in cui AFIL partecipa su mandato di Regione Lombardia.

Il Webinar si configura all'interno del Progetto CEUP2030 come TIN (Trend Innovation Network) Tech Trend Dialogue meeting (TTTDM) nell'ambito del tema Smart Materials (SM).

AGENDA

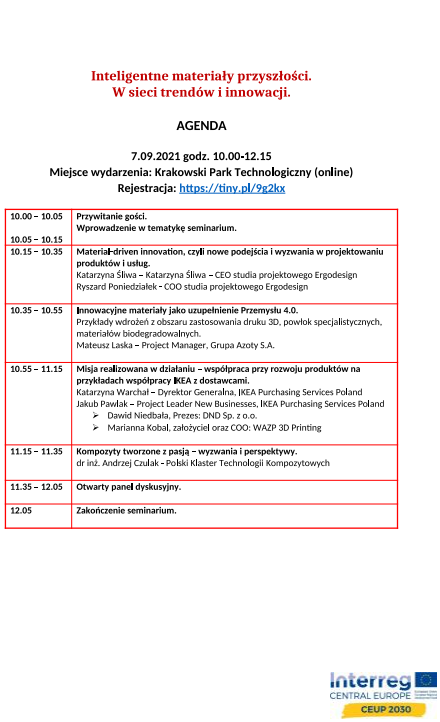
14:30-14:45 Introduzione:
- AFIL e le Strategic Communities
- Il contesto europeo

14:45-15:15 Stato dell'Arte e temi prioritari
- "Materiali polimerici e compositi intelligenti al servizio dell'economia circolare"
  Prof. G. Griffini, Politecnico di Milano (Dip. Chimica, Materiali e Ingegneria Chimica "Giulio Natta")
- "Plastronica: come la plastica può diventare smart"
  Prof. E. Sardini, Università di Brescia

15:15-15:25 Q&A

15:25-15:30 Definizione prossimi passi e calendario incontri

Associazione Fabbrica Intelligente Lombardia - Sede Legale: via Oldofredi 23 - 20124 Milano - cf/piva 08192390964
Iscrizione Registro Persone Giuridiche della Regione Lombardia n.2808
Segreteria: via Paolo VI, 1 – 25068 Sarezzo (BS) - Tel. 030 7741139 - e-mail: segreteria@afil.it



Inteligentne materiały przyszłości.
W sieci trendów i innowacji.

AGENDA

7.09.2021 godz. 10.00-12.15
Miejsce wydarzenia: Krakowski Park Technologiczny (online)
Rejestracja: https://tiny.pl/9g2kx

10.00 – 10.05 10.05 – 10.15	**Przywitanie gości.** **Wprowadzenie w tematykę seminarium.**
10.15 – 10.35	**Material-driven innovation, czyli nowe podejścia i wyzwania w projektowaniu produktów i usług.** Katarzyna Śliwa – Katarzyna Śliwa – CEO studia projektowego Ergodesign Ryszard Poniedziałek - COO studia projektowego Ergodesign
10.35 – 10.55	**Innowacyjne materiały jako uzupełnienie Przemysłu 4.0.** Przykłady wdrożeń z obszaru zastosowania druku 3D, powłok specjalistycznych, materiałów biodegradowalnych. Mateusz Laska – Project Manager, Grupa Azoty S.A.
10.55 – 11.15	**Misja realizowana w działaniu – współpraca przy rozwoju produktów na przykładach współpracy IKEA z dostawcami.** Katarzyna Warchał – Dyrektor Generalna, IKEA Purchasing Services Poland Jakub Pawlak – Project Leader New Businesses, IKEA Purchasing Services Poland ➢ Dawid Niedbała, Prezes: DND Sp. z o.o. ➢ Marianna Kobal, założyciel oraz COO: WAZP 3D Printing
11.15 – 11.35	**Kompozyty tworzone z pasją – wyzwania i perspektywy.** dr inż. Andrzej Czułak - Polski Klaster Technologii Kompozytowych
11.35 – 12.05	**Otwarty panel dyskusyjny.**
12.05	**Zakończenie seminarium.**

Figure 6 - Agenda of KPT

(Source: IWU, CEUP2030, 2021)

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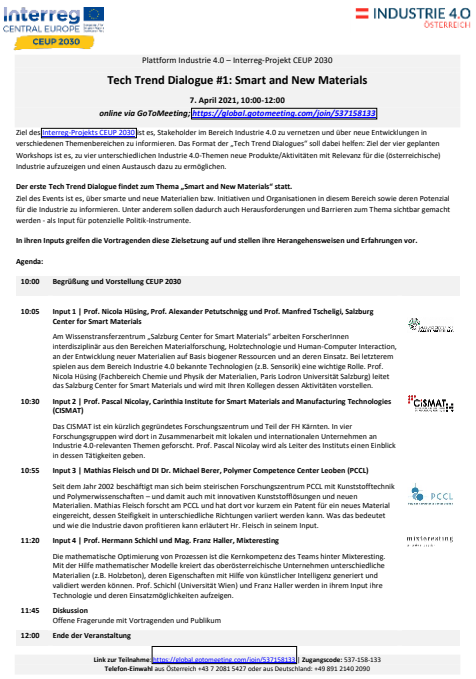
Figure 7 - Agenda of PIA

(Source: PIA, CEUP2030, 2021)



Plattform Industrie 4.0 – Interreg-Projekt CEUP 2030

Tech Trend Dialogue #1: Smart and New Materials

7. April 2021, 10:00-12:00

online via GoToMeeting; https://global.gotomeeting.com/join/537158133

Ziel des Interreg-Projekts CEUP 2030 ist es, Stakeholder im Bereich Industrie 4.0 zu vernetzen und über neue Entwicklungen in verschiedenen Themenbereichen zu informieren. Das Format der „Tech Trend Dialogues" soll dabei helfen: Ziel der vier geplanten Workshops ist es, zu vier unterschiedlichen Industrie 4.0-Themen neue Produkte/Aktivitäten mit Relevanz für die (österreichische) Industrie aufzuzeigen und einen Austausch dazu zu ermöglichen.

Der erste Tech Trend Dialogue findet zum Thema „Smart and New Materials" statt.

Ziel des Events ist es, über smarte und neue Materialien bzw. Initiativen und Organisationen in diesem Bereich sowie deren Potenzial für die Industrie zu informieren. Unter anderem sollen dadurch auch Herausforderungen und Barrieren zum Thema sichtbar gemacht werden - als Input für potenzielle Politik-Instrumente.

In ihren Inputs greifen die Vortragenden diese Zielsetzung auf und stellen ihre Herangehensweisen und Erfahrungen vor.

Agenda:

10:00	**Begrüßung und Vorstellung CEUP 2030**
10:05	**Input 1 | Prof. Nicola Hüsing, Prof. Alexander Petutschnigg und Prof. Manfred Tscheliga, Salzburg Center for Smart Materials** Am Wissenstransferzentrum „Salzburg Center for Smart Materials" arbeiten ForscherInnen interdisziplinär aus den Bereichen Materialforschung, Holztechnologie und Human-Computer Interaction, an der Entwicklung neuer Materialien auf Basis biogener Ressourcen und an deren Einsatz. Bei letzterem spielen aus dem Bereich Industrie 4.0 bekannte Technologien (z.B. Sensorik) eine wichtige Rolle. Prof. Nicola Hüsing (Fachbereich Chemie und Physik der Materialien, Paris Lodron Universität Salzburg) leitet das Salzburg Center for Smart Materials und wird mit ihren Kollegen dessen Aktivitäten vorstellen.
10:30	**Input 2 | Prof. Pascal Nicolay, Carinthia Institute for Smart Materials and Manufacturing Technologies (CISMAT)** Das CISMAT ist ein kürzlich gegründetes Forschungszentrum und Teil der FH Kärnten. In vier Forschungsgruppen wird dort in Zusammenarbeit mit lokalen und internationalen Unternehmen an Industrie 4.0-relevanten Themen geforscht. Prof. Pascal Nicolay wird als Leiter des Instituts einen Einblick in dessen Tätigkeiten geben.
10:55	**Input 3 | Mathias Fleisch und DI Dr. Michael Berer, Polymer Competence Center Leoben (PCCL)** Seit dem Jahr 2002 beschäftigt man sich beim steirischen Forschungszentrum PCCL mit Kunststofftechnik und Polymerwissenschaften – und damit auch mit innovativen Kunststoffdlösungen und neuen Materialien. Mathias Fleisch forscht am PCCL und hat dort vor kurzem ein Patent für ein neues Material eingereicht, dessen Steifigkeit in unterschiedliche Richtungen variiert werden kann. Was das bedeutet und wie die Industrie davon profitieren kann erläutert Hr. Fleisch in seinem Input.
11:20	**Input 4 | Prof. Hermann Schichl und Mag. Franz Haller, Mixteresting** Die mathematische Optimierung von Prozessen ist die Kernkompetenz des Teams hinter Mixteresting. Mit der Hilfe mathematischer Modelle kreiert das oberösterreichische Unternehmen unterschiedliche Materialien (z.B. Holzbeton), deren Eigenschaften mit Hilfe von künstlicher Intelligenz generiert und validiert werden können. Prof. Schichl (Universität Wien) und Franz Haller werden in ihrem Input ihre Technologie und deren Einsatzmöglichkeiten aufzeigen.
11:45	**Diskussion** Offene Fragerunde mit Vortragenden und Publikum
12:00	**Ende der Veranstaltung**

Link zur Teilnahme: https://global.gotomeeting.com/join/537158133 / **Zugangscode:** 537-158-133
Telefon-Einwahl aus Österreich +43 7 2081 5427 oder aus Deutschland: +49 891 2140 2090

Verein Industrie 4.0 Österreich – die Plattform für intelligente Produktion I www.plattformindustrie40.at
Mariahilfer Straße 37–39 I 1060 Wien I T: +43/ 1/ 588 39-75 I E: office@plattformindustrie40.at I ZVR-Zahl: 829608522

Online Workshop **TTTDM New Materials, D.T2.2.4**

New materials in the circular economy

DATE: 3th December 2021, Online – online ZOOM
TIME: 10:00 – 11:30

Agenda:

Registration

10:00 Project Welcome and Warm up

Presentation & Discussion

10:00–10:05	Welcome speech by Borut Zrim
10:05-10:10	Introduction of CEUP2030 project purposes by Jožek Špilak
10:10–10:40	Integration of biomaterials into artificial materials (plastics) Matjaž Milfelner, Peter Fajs and Dragan Kusić (all Tecos)
10:55-11:00	Discussion & Perspectives from Participants
11:00-11:10	Outlook & Possible Research Cooperation

Summary

11:10 Closing Words for the Event

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Figure 8 - Agenda from PTP

(Source: PTP, CEUP2030, 2021)

Considering the contents, these 10 TTTDMs had to focus on the specific CAMI4.0 topic S&A Materials or its related sub-topics and they had to be structured to facilitate the discussion of technical contents and foster the matchmaking among participants. Moreover, with the aim to exploit these events to feed WPT3 activities, partners were also strongly suggested to address key challenges and barriers that might be overcome with the support of institutions, for example through the organisation of round tables with stakeholders involved representing diverse type of organisation.

The partners had a diverse audience representing the triple-helix attend the session. As described in the Stakeholder section of this report, we provide some images to show how the partner's stakeholders attended the session. In contrast to the IPS TTTDMs, some of the S&A Material TTTDMs were held physically which enabled a comparison especially regarding the methodologies used and the outcomes of these events.

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Figure 9 - PTP Attendance

(Source : PTP, CEUP2030, 2021)

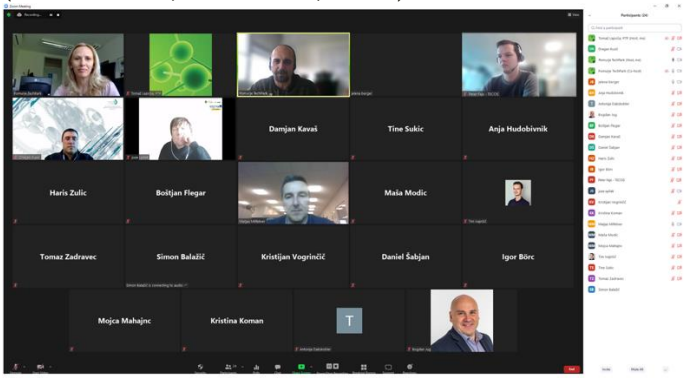

Figure 10 - IWU Attendance

(Source: IWU, CEUP2030, 2020)

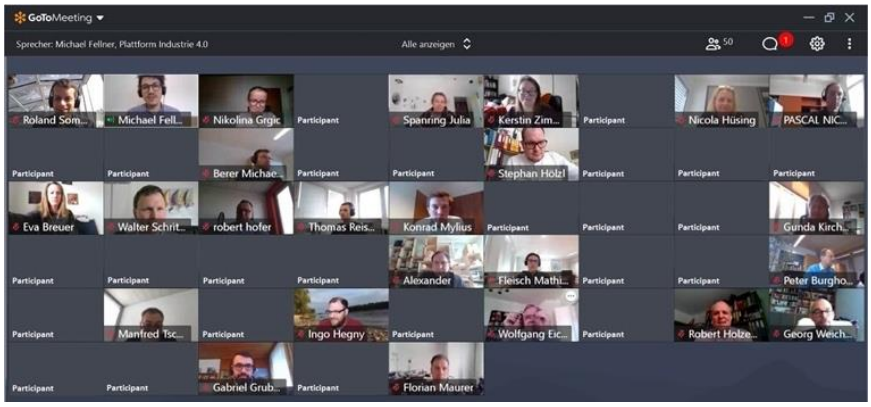

Figure 11 - PIA Attendance

(Source : PIA, CEUP2030, 2021)

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3.3. Methodologies used

Within the TTTDM structure, partners were expected to build in a co-creation atmosphere to ensure that foresight was appropriately gathered from the attending experts, and feedback could be ensured from the remaining participants. Due to the COVID-19 Pandemic, the sessions were nearly held entirely virtually, which was a challenge sighted by many of the Partners. In Figure 12, an overview of the methodologies utilised in the TTTDMs is provided.

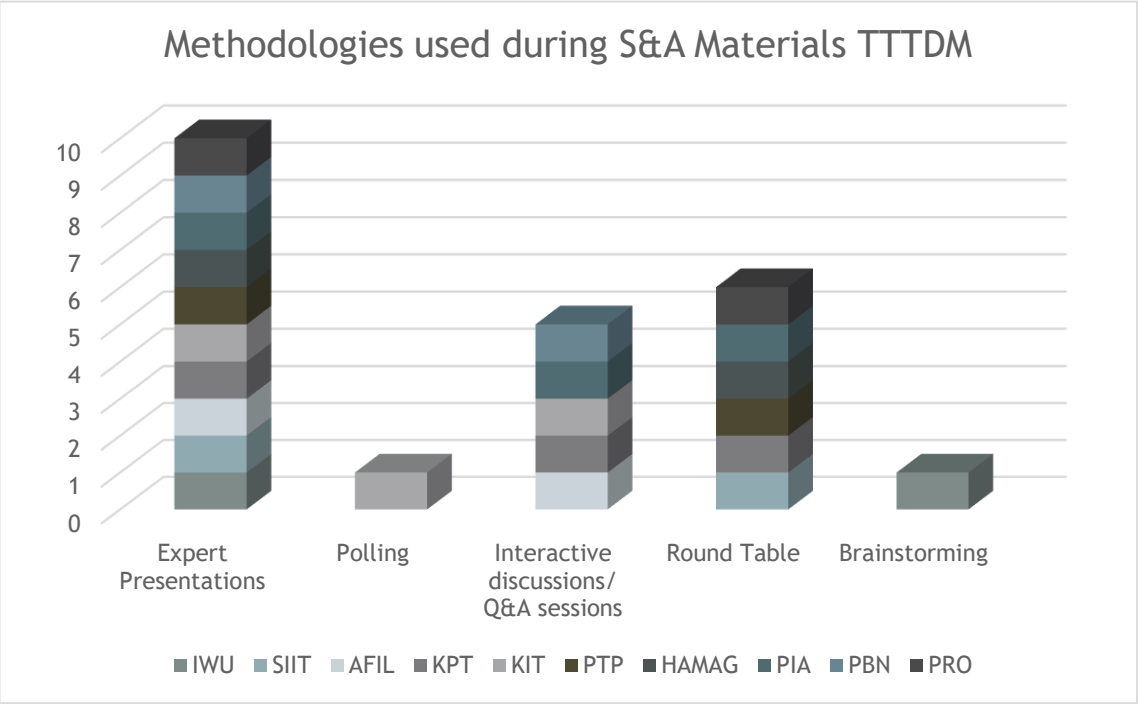

Figure 12 - Methodologies used (Source: Author generated from S&A Materials TTTDM reporting, CEUP2030, 2021)

Table 5. Methodologies used (Source: Author generated from S&A Materials TTTDM reporting, CEUP2030, 2021)

Expert Presentation	Polling	Interactive discussions/ Q&A sessions	Round Table	Brainstorming
10	1	5	6	1

First a session of introduction enabled all the stakeholders to understand the context of the project CEUP2030, of the ecosystem and the framework of the TTTDMs. A special reference including a definition of the topic S&A Materials was presented. During this initial phase, PPs clarified the scope of the meeting to the participants and explained the structure of the event and the expected outcomes of each session. Furthermore, if the following technical discussion was sufficiently strong and focused, the introduction has been used also to provide a regional perspective on the current expertise and capabilities of attending stakeholders.

Therefore, the introduction through presentations increased the awareness of participants on the specific topic of S&A Materials and providing common understanding on the terminology of the concepts used. PPs had the responsibility to provide not only a clear vision of CEUP2030 project in terms of objectives, tasks and expected outcomes but also to define a strong base in term on terminology understanding to facilitate further exchanges.

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The introduction was then followed by a technical panel. PPs had to find interesting and relevant experts on the topic to showcase their progress and to provide an overview of the current context of S&A Materials. During this time, contributing experts:

- Provided an overview of the ecosystem on S&A Materials at different levels (regional, national and European) providing insights on their progress and main challenges that need to be overcome. For instance, a specific need raising awareness on funding opportunities was showcased.
- Introduced Initiatives and S&A Materials-based solutions in different sectors and not only in the textile industry. For instance, PRO focused its TTTDM on the use of Smart Material in the medical sector.
- Highlighted what are the future trends and challenges regarding the application of S&A Materials innovative solutions. The objective of this part was to convince the audience of the usefulness and cruciality of fostering this topic as it increases efficiency and productivity especially for businesses.
- Shared Best Practices that enabled participants to see how to overcome or cope with challenges.
- Fostered ideas conception. By fostering exchanges and presentation of S&A Materials Solutions, not only were participants able to develop a better understanding of the ecosystem with its needs and challenges but also fostered reflexion to create new solutions and to engage new cooperation between the stakeholders present in the TTTDM.

Therefore, the expert panel aimed at increasing the audience knowledge on the specific topic of S&A Material. The audience was indeed able to hear from specialists and experts on the field from different perspectives as the PPs had to invite different types of stakeholders to talk. Lots of the speakers were from Businesses and Research Organizations and were therefore able to present the innovative solutions they are working on. In order to have a fruitful and efficient session, presentations should include different perspectives, both technical providers and end-users, and should be strongly linked to industrial ecosystem giving concreteness to the topic. Real application examples and risk analysis have been showed. Furthermore, to make the technical panel more interesting, interactive discussion sessions or Q&A Sessions were held at the end of the TTTDMs for two main reasons:

- Asking the relevant questions raised by the qualitative presentations given by the experts and foster a better understanding of what is at stake.
- Facilitate the creation and strengthening of a network around the topic of S&A Materials.

Therefore, this final session promoted the cooperation between all participants despite their type (Policy Makers, Businesses, Higher Education and Research Centres, BSO…). The overall objective of this interactive session was to enhance synergies between the audience to align not only knowledge and understanding but also needs and interests in the topic of S&A Materials.

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3.4. Reporting

In order to build on the outcomes of TTTDM and to generate useful insights for the projects, a detailed reporting of the meetings had to be elaborated by each partner. **Therefore, each PP had to create a report of each TTTDM including the following aspects**:

- List and description of attending stakeholders
- Description of the TTTDM including methodologies used
- Summary of the outcomes and key achievements
- Key lessons learned
    - *For stakeholders: potential collaboration on strategic topics, priorities-gap-barriers for technologies development and updates*
    - *For PP: improvements for upcoming TTTDM, recommendations to be highlighted for RIS3 Round Table in WPT3, potential flagship projects to be developed*

Besides reporting requirements, communication is another important and strategic task to be implemented in CEUP2030. Therefore, PPs were recommended to collect as many contents as possible from the workshops (i.e., pictures, video content-if feasible-, meeting notes, flipcharts, and presentations). Thanks to this materials, relevant content for CEUP2030 communications have been elaborated and disseminated through the project communication channels. While during the event social media posts can be exploited to share real-time updates on TTTDM, reports and other media contents can be included in dedicated articles that can be published after the meetings.

3.5. Results analysis

To build this report, 10 events (TTTDM) on S&A Materials were studied (1 per partner). First, information was collected in the templates that can be found in the Annex. Then the data was compiled in an Excel sheet to compare and codify the collected results. A first analysis of the answers towards the held TTTDMs was elaborated. Every question has been treated independently and an overall conclusion has been made at the end.

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4. Results

4.1. Overview of the TTTDM

This section reports on what the partners were able to pull out from the TTTDM they organized. Below is a table summarizing the TTTDM on S&A Materials that were held by the partners in 2021.Most events were held online due to the COVID-19 pandemic, however two Partners (Fraunhofer IWU and HAMAG), were able to hold physical events.

Table 6. Summary of the S&A Materials TTTDM (Source: Author generated, CEUP2030, 2021)

PPs	TTTDM S&A Materials	TIN Role	Total No. Participants	Summary of the event
IWU	2nd November 2021	Lead	12	Objective: Present good practices of internationalisation strategies and present upcoming service offers for the smart3 network members. Methodology: Brainstorming and discussions
SIIT	27th July 2021	Core	51	Objective: Present the situation of Liguria Region in the field of National Recovery and resilience plan. Methodology: Presentations from regional policy makers and discussions.
AFIL	28th October 2021	Core	29	Objective: Introduce the main current challenges related to S&A Materials, highlight the available technologies by showcasing use-cases and showcase the opportunity of inter-regional collaboration through the Vanguard initiative. Methodology: Two technical presentations on the State of Art and current Research and Innovation topics for polymeric materials followed by an open discussion.
KPT	7th September 2021	Core	20	Objective: Present Case studies on Material driven solutions. Methodology: Presentation of Solution providers followed by discussions and Q&A sessions
KIT	30th September 2021	Learner	28	Objective: Promote new topics such as new materials for 3D printing and introduce new platforms focusing on digital materials. Methodology: Expert Presentation followed by interactive discussions

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PTP	3rd December 2021	Learner	24	Objective: Raise awareness on Industry 4.0 and more specifically on the integration of biomaterials into artificial intelligence and robotics. Methodology: Presentations and Q&A sessions
HAMAG	30th November 2021	Learner	21	Objective: Provide an overview of the current state of the affairs in smart materials research and its implementation in industry in Croatia. Methodology: Presentations of Good Practices in SMEs and research followed by Round Tables.
PIA	7th April 2021	Learner	59	Objective: Showcase different initiatives, businesses and approaches on Smart Materials and raise awareness on needs and policy instruments. Methodology: Presentations from companies flowed by Q&A sessions
PBN	19th November 2021	Learner	16	Objective: Introduce the project DanubeS3 Cluster and present the future plans of PBN/am-LAB. Methodology: Presentations and Q&A sessions
PRO	2nd – 3rd December 2021	Learner	182	Objective: Raise awareness on the use of Smart Materials in Medical Manufacturing. Methodology: Expert's presentations

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4.1.1. Technologies and Applications discussed

Each partners talked more precisely about specific topics included in S&A Materials

The partners discussed specific topics they decided to foster inside the topics of S&A Materials. These specific topics are gathered in the following table:

PP Name	Topics discussed
IWU	Engagement of network members and cluster organizations (such as smart3); Programmable materials
SIIT	Green chemistry; Hydrogen production; Additive manufacturing; Sensors and bio-sensors; Energy production; Carbon capture; Bio-technologies.
AFIL	Advanced polymers: different applications, technologies and materials
KPT	Use of polymers: Material driven solutions including 3D printing
KIT	New materials for 3D Printing; Innovative digital materials; Smart Material platforms
PTP	Integration of biomaterials into artificial materials (plastics) to improve the mechanical properties of artificial materials; Traceability of plastic (from preparation to decomposition); Suitable materials for robotic grippers that have built-in sensors.
HAMAG	3D printed wire technology; Process of elastomeric coating bonding and dispensing textiles; Special manufacturing processes.
PIA	Development of new materials based on biogenic resources; Advanced design processes and tools; 3D printed fibre composites; Agile Manufacturing; Sensor integration mechatronic systems; Plastic and polymer technologies; More efficient concrete.
PBN	3D Technologies; Extended Reality; Robotics
PRO	3D printing for the medical sector

Table 7. Topics mentioned during the TTTDM (Source: Author generated from S&A Materials TTTDM reporting, CEUP2030, 2021)

Moreover, clusters of technological sub-topics were defined from the creation of the TINs as the key focus of the expert speakers involved in the TTTDMs. This provided us insights into the key issues faced by the TIN S&A Materials, and also a deeper understanding that many experts do not see a single technology-future, mainly a series of tools which can be used jointly to solve foreseen challenges.

Therefore, the 4 sub-topics have been defined for S&A Materials:

- **Smart Structures & Systems** which refers to increasing the functional density in technical systems by merging functions and structure at the material level.
- **Process-related sensor technology** which refers to the knowledge of process characteristics thanks to data collection to be able to control and regulate the processes in real time.

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- **Smart materials Network** which refers to connecting the partners in the area of Smart and Advanced materials to enhance cooperation and therefore innovative products to emerge.
- **Functional printing** which refers to the development of personalized and customized products opposed to mass and identical production.

In Figure 13, we can see the sub-topics mentioned by each partner's TTTDM.

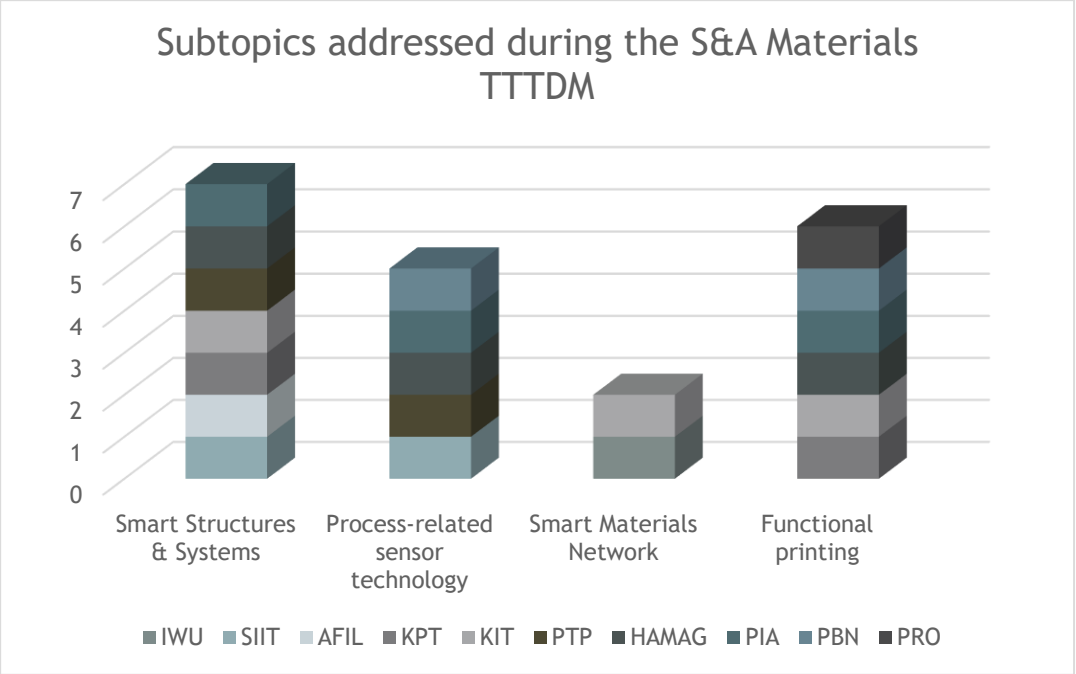

Figure 13 - Topics mentioned during the TTTDM (Source: Author generated from S&A Materials TTTDM reporting, CEUP2030, 2021)

Table 8. Topics mentioned during the TTTDM (Source: Author generated from S&A Materials TTTDM reporting, CEUP2030, 2021)

Smart Structures & Systems	Process-related sensor technology	Smart Materials sensors	Functional Printing
7	5	2	6

To understand the context of these finding, here is a table gathering the main insights from the agendas of the TTTDM held on S&A Materials:

Table 9. Topics addressed during S&A Materials TTTDM (Source: Agenda from S&A Materials TTTDM, CEUP2030, 2021)

Name of the Partner	Topics addressed through presentations from experts
IWU	Future smart3 orientation and internationalization Input of best practices in cluster management & internationalization strategies Presentation & discussion about smart3 projects and CEUP2030 flagship on smart materials

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SIIT	Regional Innovation System National Recovery and Resilience Plan Operational areas & services of the Poles for the territory
AFIL	"Intelligent polymeric and composite materials at the service of circular economy" - Prof. G. Griffini, Politecnico di Milano (Dept. of Chemistry, Materials and Chemical Engineering "Giulio Natta") "Plastronics: how plastic can become smart" Prof. E. Sardini, University of Brescia
KPT	Material-driven innovation, or new approaches and challenges in product and service design. - Katarzyna Śliwa - CEO of Ergodesign studio Ryszard Poniedziałek - COO of Ergodesign studio Innovative materials as a complement to Industry 4.0. Examples of implementations in the field of 3D printing, specialty coatings, biodegradable materials. - Mateusz Laska - Project Manager, Grupa Azoty S.A. Mission in action - cooperation in product development based on IKEA cooperation with suppliers. - Katarzyna Warchał - General Director, IKEA Purchasing Services Poland Jakub Pawlak - Project Leader New Businesses, IKEA Purchasing Services Poland Dawid Niedbała, President: DNDSp.zo.o. Marianna Kobal, Founder Loraz COO: WAZP3DPrinting Composites made with passion - challenges and perspectives. - Andrzej Czulak, PhD - Polish Cluster of Composite Technologies
KIT	„Smart Vision Devices with DL support for Image Capture and Evaluation" CEO, EVT Eye Vision Technology GmbH - Mr. Michael Beising „Overview and perspectives in machine learning" – Institute for Automation and Applied Informatics, Karlsruhe Institute of Technology - Prof. Dr. Markus Reischl "Connected by Materials" Fraunhofer IWU - Mrs. Laura Salomon „Fused Filament Fabrication beyond polymers "– Institute for Applied Materials, Karlsruhe Institute of Technology - Prof. Dr. Thomas Hanemann „ Innovation Platform MaterialDigital" – Institute of Nanotechnology, Karlsruhe Institute of Technology - Dr. Heike Fliegl
PTP	Integration of biomaterials into artificial materials (plastics) - Matjaž Milfelner, Peter Fajs and Dragan Kusić (Tecos)
HAMAG	NTT New Textile Technologies d.o.o.: "Challenges in smart clothing production" (Hans R. Bauer, director, Jelena Buhanec, Business Manager) Šestan-Busch d.o.o.: "Use of smart materials in the production of helmets and protective masks" (MBA Goran Basarac, Executive Director for Strategic Development and Project Implementation, President of the Defense Industry Competitiveness Cluster)

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	Ruđer Bošković Institute, Zagreb, Department of Materials Physics, Laboratory of Materials for Energy Conversion and Sensors and Department of Chemistry of Materials, Laboratory for Functional Materials: "Basic research and application potentials of new functional materials and sensors" (Andreja Gajović, PhD, Head of the Laboratory of Materials for Energy Conversion and Sensors, Scientific Adviser, Luka Pavić, PhD, Research Associate, Laboratory for Functional Materials) Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb: "Materials in 4.0" (Prof. Emeritus Igor Čatić, PhD)
PIA	"Salzburg Center for Smart Materials" - Prof. Nicola Hüsing, Prof. Alexander Petutschnigg and Prof. Manfred Tscheligi, Salzburg Center for Smart Materials “Research on Industry 4.0-relevant topics in collaboration with local and international companies” - Prof. Pascal Nicolay, Carinthia Institute for Smart Materials and Manufacturing Technologies (CISMAT) “Plastics technology and polymer science” - Mathias Fleisch and DI Dr. Michael Berer, Polymer Competence Center Leoben (PCCL) “Mathematical optimization of processes” - Prof. Hermann Schichl and Mag. Franz Haller, Mixteresting
PBN	3D printing (Boldizsár Könczöl- computer science engineer) CGI animation (Boldizsár Könczöl- computer science engineer) 3D scanning (Ferenc Tolner-Production and Innovation manager) AR technology (Ádám Takács, Electric engineer & Innovation manager) Robotics solutions (Patrik Haraszti-Robotics Technician)

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PRO	3D Food Printing, the Next Frontier of Additive Manufacturing - Chua Chee Kai, SUTD Research: Laser-Based High Resolution 3D Printing for Biomedical Applications - Aleksandr Ovsianikov, TU Vienna 3D Bioprinting of Human Skin: Technology, Applications and Future - Diego Velasco Bayón, UC3M Design and Manufacturing Strategies: From Tissue Engineering Constructs Towards Living Materials - Andrés Díaz Lantada, UPM Design for Additive Manufacturing Applied to Lightweight and Biomechanical Systems - Giorgio De Pasquale, POLITO Industry: 3D-Printing-by-Design: A Solution for Next Generation Life Science Applications - Jan Schrooten, Antleron Lithography-based Ceramic Manufacturing for Fabricating Multi-Material Components - Martin Schwentenwein, Lithoz 3D Printing Utilization in the Production of Personalized Implants - Michal Síbr, Prospon 3D Printing in Orthopedics. Opportunities and Pitfalls - Martin Petraschka, Kerkoc Stratasys Digital Anatomy printer for lifelike anatomical models - Arnaud Toutain, Stratasys Use-Cases: 3D Printing Dental Implants – an Introduction of the Inkplant Project - Christoph Staudigl, Kepler Uni.Klinikum Linz Treatment of Meniscal and Osteochondral Defects - a Clinical Tightrope Walk - Andreas Enz, MedUni Rostock Additively Manufactured Human Oral Mucosa Model for Surgical Simulation - Gunpreet Oberoi, MedUni Vienna Industrialization of 3D Printed Medical Devices for Clinical Use - Nicolas Bouduban, Swiss m4m Center National projects: M3dRES, Medusa, CAMed, CDLab, Fam-3D International projects: INKplant, GIOTTO, Smart Bone Regeneration, ADMAIORA, RESTORE, cmRNAbone, BRAV3, I-SMarD, TRIANKLE

Through these events held online and physically, the speakers provided plenary presentations on cutting edge topics in the area of S&A Materials, as described previously. Below in Figure 14 to 18, you can see some examples of such subjects which were discussed presentations and exchanges:

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Figure 14 - Presentation from AFIL (Source: AFIL, CEUP2030, 2021)

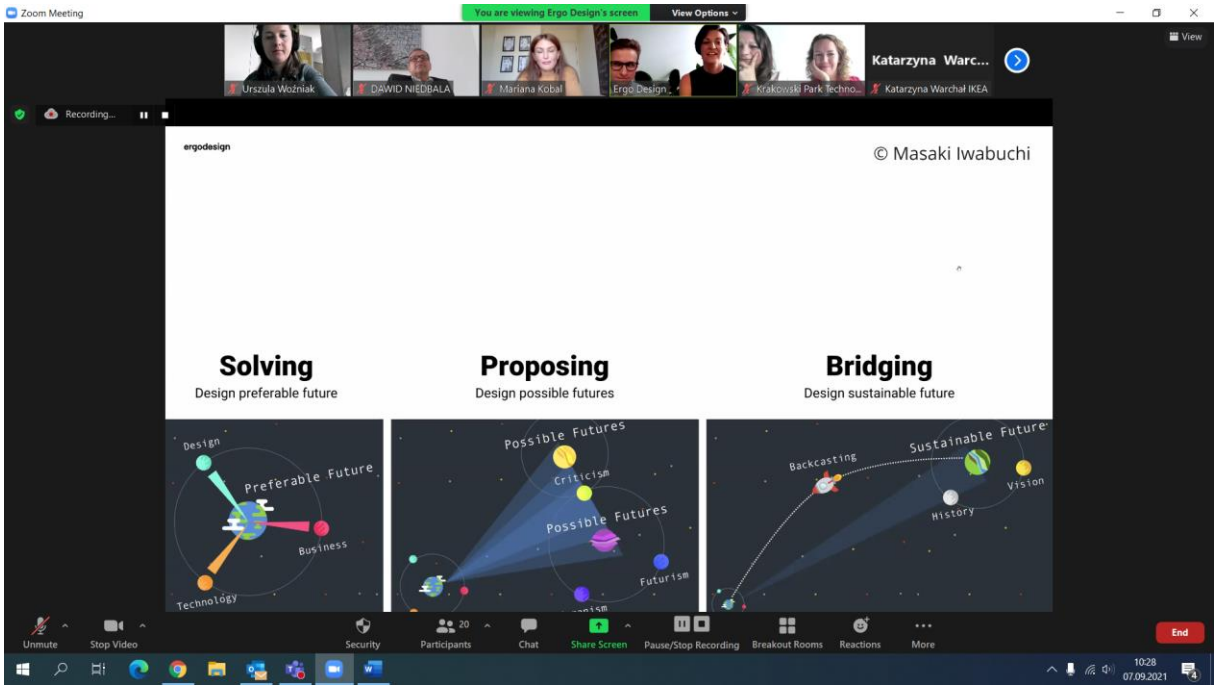

Figure 15 - Presentation from KPT (Source: HAMAG, CEUP2030, 2021)

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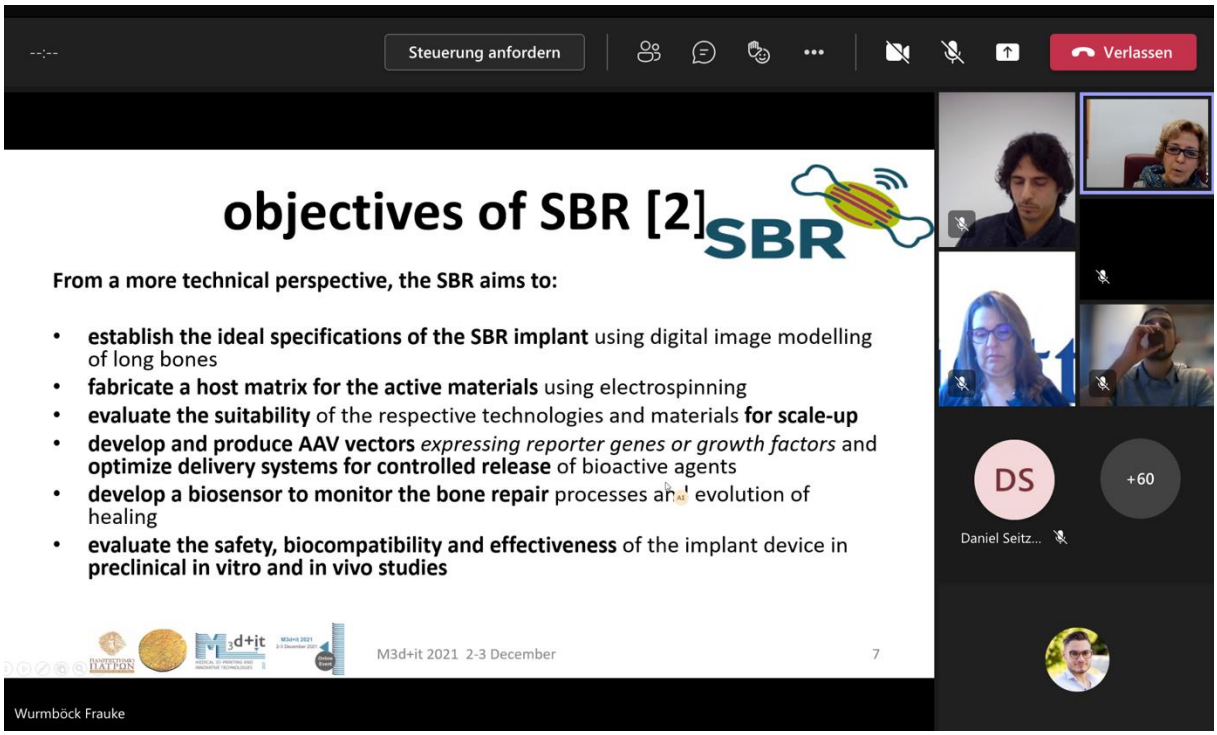

Figure 16 - Presentation from PRO (Source: IWU, CEUP2030, 2021)

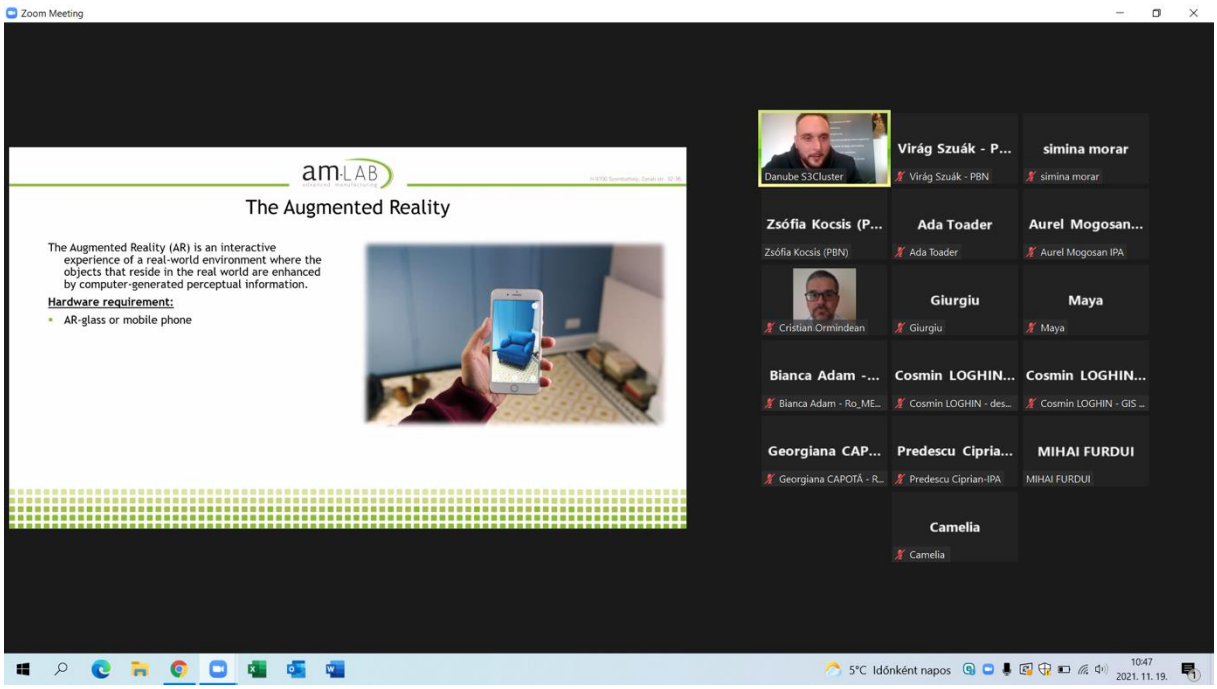

Figure 17 - Presentation from PBN (Source: PBN, CEUP2030, 2021)

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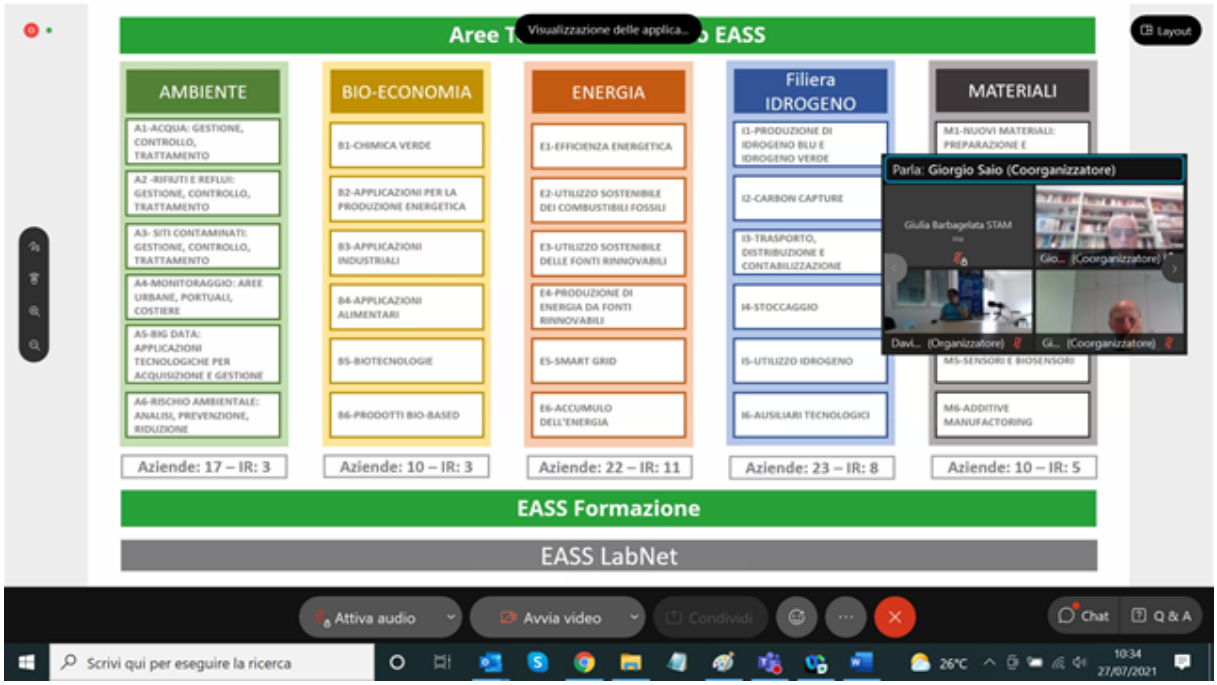

Figure 18 - Presentation from SIIT (Source: SIIT, CEUP2030, 2021)

Figure 19 - Presentation from KIT (Source: KIT, CEUP2030, 2021)

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4.1.2. Key Outcomes of the TTTDMs on Smart & Advanced Materials

First, it was showcased that new materials are essentials for innovation in the manufacturing sector. For instance, KPT showcased that, smart materials technologies, are starting to be recognized as a crucial element of the industry development. HAMAG highlighted the need to extend the use of Smart Materials to another field than the textile industry.

Second, TTTDM represented a great opportunity for stakeholders from different types of organizations (Research, Business, Policymakers mainly) to talk to each other on relevant technologies associated to S&A Materials. The TTTDM created synergies between different types of stakeholders by engaging conversation and enabling businesses to present their current innovations but also their current needs and challenges that cooperation with different entities could hinder. For instance, AFIL hosted a TTTDM starting with the collection of current challenges and the development of innovative solutions to engage discussions and then collaboration between different types of stakeholders including research centres, industrial actors and policy makers. The TTTDM hosted by KIT also mentioned the necessity to include all types of stakeholders including SMEs. These TTTDM were therefore a great opportunity to showcase how each type of stakeholder could benefit from the development of technologies in the field of S&A Materials. One of the challenges raised by KPT was the necessity to match technology suppliers offers with companies needs in terms of technological upgrades. HAMAG during its TTTDM demonstrated the opportunities for improvements to increase investments especially in innovative SMEs in a way that policy makers provide more financial instruments and calls directly targeting Smart Materials.

Events such as TTTDM are therefore crucial not only for the ecosystem to have an overview of the current trends and current needs and challenges but also to keep as many stakeholders as possible involved. As demonstrated by IWU, it is crucial to keep touch with all the speakers and the participants even after the TTTDM to foster the ecosystem. It can be by keeping them informed on the development of projects or on upcoming project work or on funding opportunities that could be interesting for them. According to IWU, an urgent need to develop the Network around S&A Materials has been demonstrated by these TTTDM. PBN also highlighted the necessity to keep as many stakeholders as possible on upcoming projects and submissions to be able to develop optimized partnerships and cooperation.

Moreover, the Q&A sessions held by some partners, for instance AFIL, enabled connections to be fostered between different stakeholders but also the partners to realize how much interest there was in this topic of S&A Materials.

Regarding the content, two special interests were raised:

- The first one regarding 3D technologies associated to Smart Materials as at least 6 partners invited speakers to express their opinions and present their innovative solutions on the topic (KIT, PBN, PIA, PRO, HAMAG, KPT)
- The second one on the use and capacities of the composite polymers as at least 4 partners (PIA, AFIL, KPT, PTP) invited speakers to talk about it during their TTTDM. Plastic and polymer sciences represent today a great interest, the main questions lying in how the industry could profit from these innovations. However, cost is one of the biggest challenges while developing new materials as explained during the TTTDM hold by PTP.

Moreover, great examples of already installed cooperation have been demonstrated such as the research made by CISMAT, represented during the TTTDM from PIA, which collaborates with local and international companies on topics such as Smart Materials and Structures, 3D

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printed Fibres composites or also the integration of Sensors in Additive Manufacturing. Partners such as AFIL with the Vanguard Initiative used Use Cases to showcase the potential of inter-regional connections and synergies aimed at supporting the development of the topic of S&A Materials.

The concept of sustainability in Smart Materials was also mentioned for instance within the TTTDM hold by PIA where a more efficient concrete mixture was presented to reduce CO2 emission compared to regular concrete used in the building sector.

Therefore, the main outcomes have been collected and reported on the following table:

Table 10. Main outcomes (Source: Author generated from S&A Materials TTTDM reporting, CEUP2030, 2021)

OUTCOMES	BENEFITS
Raise awareness on key challenges and needs in the Smart & Advanced Materials sector	All the partners used experts' presentation mainly from Business and Research Organizations to give an overview of the ecosystem in the topic of S&A Materials. Most of the presentations showcased the current status, but also future trends and challenges to reach these future objectives. Sharing on innovative projects and products raised awareness on the key challenges which are: cost of research and implementation of innovative solutions and therefore need to have funding opportunities, raising awareness on the potential benefits for all types of stakeholders to foster the topic of S&A Material and therefore enhance the territorial competitiveness.
Raise Awareness on the potential of Smart Material in the Manufacturing sector and not only in the textile industry.	Today, it seems that S&A Materials is a topic mainly categorized for the textile industry while it could be a real asset for the overall manufacturing sector. It is therefore very important to develop events such as the TTTDM to raise awareness on the great opportunities that Smart Materials can offer. For instance, PRO focused its TTTDM on the application of S&A Materials in the Medical sector.
Identification of regional expertise and competences. Sharing of Best Practices and innovative solutions.	To be able to create an optimized ecosystem developing optimized technologies in the topic of S&A Material, it is crucial to understand the current context. Therefore, all the partners invited businesses to showcase their progress and innovative solutions including Smart Materials. By sharing Best Practices and Use Cases, not only can the participants understand the ecosystem and create connections with other stakeholders but also it can create inspiration for future projects. It is indeed very important that as many stakeholders as possible understand what is at stake and what are the potential benefits that Smart Materials can

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	offer in so many different sectors. By showcasing different application in different sectors, the TTTDM enabled new ideas and concept to emerge.
Awareness on current opportunities and upcoming projects and submissions	The speakers were invited to not only share their vision on Smart Materials and to present their innovative solutions but were also present to create relevant connections. Indeed, this outcome has 2 benefits: 1) Raising challenges so the ecosystem can try to mitigate these issues, such as funding challenges. Especially it enabled Policy makers to understand how they could foster this topic by adjusting their support and funding opportunities; 2) By sharing their innovative experiences and solutions, speakers were able to be reached by relevant stakeholders to build common future projects.
Creation of active networks and communities	As it was specifically showcased by IWU, creating and fostering a network around the topic of S&A Materials is crucial to accelerate and enhance the development of this topic. The TTTDM should therefore be replicated and supported by other actions to enhance exchanges between all types of stakeholders. The overall objective here is to keep the links that were created between the stakeholders (speakers and participants) during the TTTDM. It is important to understand that if there are no cooperation opportunities between 2 stakeholders today, it doesn't mean that there will never be. Therefore, it is crucial that the full ecosystem stay connected while growing to enable the most optimized and relevant collaborations to emerge around common projects on S&A Materials.

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4.1.3. Key Lessons Learned

This section provides insights on the key lessons learned developed by the partners and the participants of the TTTDM on Smart Materials. This section is divided in 2 parts:

- Key lessons learned from a methodological point of view and therefore on the organization of events such as the TTTDM aimed at fostering the ecosystem on a specific topic, here Smart Materials
- Key lessons learned from a content point of view which refers to what was exactly discussed during the TTTDM.

4.1.3.1. Methodology and Organization of the TTTDMs

To build upon these 10 workshops, it is crucial to identify the strengths and weaknesses of the events. The table below summarizes these observations:

Table 11. Strengths & Weaknesses of the organization of TTTDM (Source: Author generated from S&A Materials TTTDM reporting, CEUP2030, 2021)

Strengths	Weaknesses
• The online format enabled partners to reach a wider number and types of participants and from further countries in case of workshops held in English language. • IWU and HAMAG were the only one able to deliver their TTTDM on site. It fostered the build of trust and participation that were lacking in the online events. • Showcasing different initiatives enables the participants to have concrete examples on the potential of the topic of S&A Materials. • Speakers were able to present themselves towards policy makers and industrial partners to show their willingness and the possibilities for cooperation. • Q&A sessions enabled the participants to ask their questions and raised their concerns regarding the innovative solutions presented.	• The online format due to COVID-19 hindered open-talk and therefore trust for future cooperation. It has been demonstrated that physical events facilitate the exchanges especially starting new interactions. • In general, online events hinder direct cooperation and talks. It is emphasized by the fact that only the speakers have their cameras on and therefore the audience can't see the other participants. • Online events make it harder for participants to participate even if the event allowed them. For instance, even though most of the partners implemented Q&A sessions, it is harder for participants to asks their question as they don't have an overview of the audience. • CEUP2030, being an international project including different nationalities, TTTDM hold in national languages hinder other nationalities to participate to the events.

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4.1.3.2. Content of the TTTDMs

Table 12. Strengths & Weaknesses on TTTDM contents

(Source: Author generated from S&A Materials TTTDM reporting, CEUP2030, 2021)

Strengths	Weaknesses
• The TTTDM represented the opportunity to test and verify already existing best practices and solutions, encouraging them to think to specific applications on their business. • They showcased the necessity to involve the participants of the future projects right from the start of idea creation to increase the open mindedness for new approaches and show the purpose of such actions. • TTTDM highlighted the great potential to develop smart materials technologies thanks to cooperation between research centres and Businesses and the support of Policy-Makers. TTTDM enabled the connections between different types of stakeholders to foster future cooperation. • TTTDM helped mitigate the challenge of raising awareness on the possibilities coming from the implementation of new materials-based technologies • TTTDM raised awareness on the benefits of Smart Materials technologies for all types of stakeholders and from different sectors. • The link between different CAMI 4.0 made by the creation of a combined event by PBN enabled them to reach a wider range of stakeholders and therefore to enhance a bigger network.	• Financial instruments to foster the topic of Smart Materials could have been more discussed and will have to be developed in future exchanges. • SMEs need flexible measures and expressed urgent needs to develop their innovative solutions. Even though, TTTDM involved Policy-Makers, the timing to answer current needs is key in the success of SMEs to develop their solutions. TTTDM should therefore focus on follow-ups to make sure that solutions especially from Policy-makers are found to answer the challenges raised during the TTTDM.

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5. Discussion and Recommendations

This section provides insights on how to build upon the TIN activities and events to foster cooperation. The S&A Materials TTTDM events showcased the relevancy of communication to foster common understanding towards the subject of Intelligent Production Systems, specifically, and at times, generally for Industry 4.0. The following graph showcase the main ideas to be fostered in future actions to enhance the changing process towards digitalization.

5.1. Key Takeaways regarding the TTTDMs

The figure below provides the 5 key takeaways identified thanks to the 10 TTTDM:

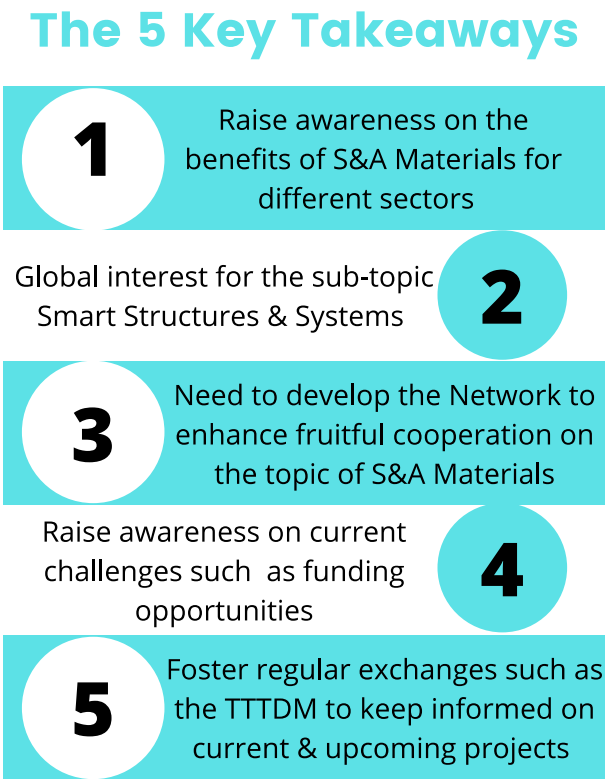

Figure 20 - 5 Key Takeaways (Source: Author generated from S&A Materials TTTDM reporting, CEUP2030, 2021)

5.2. Connection to Flagships project

The S&A Material TTTDMs were also aimed at supporting the definition, development and submission of the flagship projects associated to the topic. For each CAMI 4.0 topic including S&A Materials, a total of 5 flagship projects meaning 2 flagship projects per partner in 2 of the 4 CAMI4.0 topics were planned to be defined. IWU coordinated the activities within the partnership for S&A Materials and it was anticipated that the TIN leader together with the identified core partners AFIL, KPT, SIIT will be defining and submitting S&A Materials flagship projects. This CAMI 4.0 topic has the particularity to have only 4 core members as the partners had the choice of the two CAMI 4.0 topic they wanted to foster.

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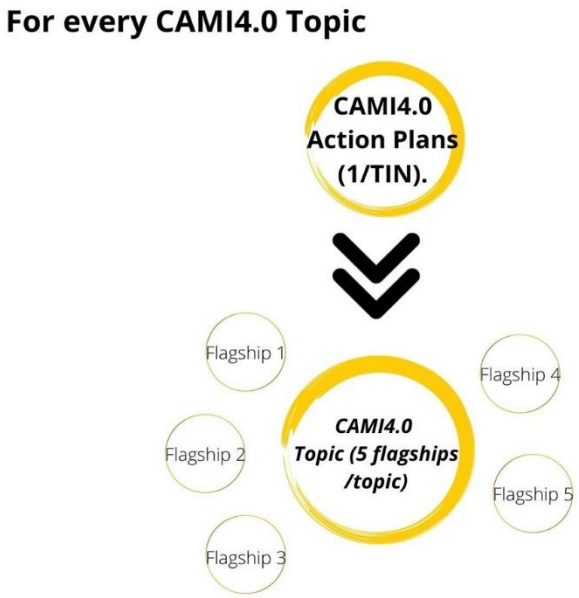

Figure 21 - Actions to deliver 5 Flagships project/ TIN (Source: DT3.3.1, CEUP2030, 2021)

The table below summarize the Flagship/ Use Case from Partners included in the TIN S&A Materials:

Table 13. S&A Materials Use Cases/ Flagships (Source: DT1.3.3, CEUP2030, 2020)

Partners' Name	Flagship/ Use-Case name	Short description	Policy Instrument
IWU	Piezoelectric process monitoring for end milling cutters (PieMontE)	Obtain effective information is the use of too integrated sensors with a piezoelectric layer close to the process and therefore increase productivity.	Zwanzig20 program/initiative smart3 -BMBF (German Federal Ministry of Education and Research).
KPT	The Vanguard Initiative Use Case: Production and application of biodegradable polymers produced by bacteria from bioresources.	show case on production and application of biodegradable polymers produced by bacteria - polyhydroxyalkanoates (PHAs) - from bioresources. The solution is applicable for two main sectors: a) life-science b) industry.	Subsidized Service Funding opportunities in Horizon Europe - Innovative Europe Cascade Funding – to be defined.
AFIL	Strategic Community on Smart Materials	Foster the creation of a new Strategic Community focused on functional plastics.	Multiple : Private & Public.
SIIT	EU-ALLIANCE	Intensify cluster and business network collaboration across borders andacross sectorial boundaries and to support the	COSME call COS-CLUSINT- 2020-3-01

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		establishment of European Strategic Cluster Partnerships.	

5.3. To build upon the Common Policy Use Case in Smart & Advanced Materials

The TTTDMs together with the definition & implementation of the flagship projects have provided the partners with great insights into how to build their Common Policy Use Case in Smart & Advanced Materials as shown in the figure below. Indeed, we observed a great common interest on Smart Structures and Systems. 7/10 of the partners introduced strong knowledge through experts mainly from Businesses and Research Organizations on this sub-topic.

It is also very interesting to notice that as for the IPS CAMI 4.0 topic, the use of 3D technologies represents a great interest in the CAMI 4.0 topic Smart & Advanced Materials. Therefore, great interest was also showcased toward the development of functional printing in both IPS and Smart Materials field as at least 6 partners included presentations on the topic in their TTTDM on Smart & Advanced Materials. This point continues to emphasize the connected nature of all four CAMI4.0 Topics in CEUP 2030, and should encourage PPs to look across technology areas to develop the Common Policy Use Case.

Processes related sensor technologies, with at least 5 TTTDM providing insights on this sub-topic, should also be checked and followed in the future. Finally, we can notice a lack of special interest in fostering the network around Smart Materials technologies. This lack of interest seems to have two potential explanations. The first one is that the other topics as they are more technology-focused were more interesting to foster as they are directly related to businesses and research centres. The second one is that developing the other sub-topics automatically developed the Network and therefore the partners didn't identify a real need to focus specific presentations or initiative on fostering the network. It is more likely that the partners wish to foster the network by developing events such as TTTDM to enhance exchanges and therefore cooperation. IWU, as leader of this CAMI 4.0 topic was one of the 2 partners which decided to focus its TTTDM on fostering the Network on the topic of S&A Materials. Thus, as leader, it could create a common understanding with the other partners on why specific initiatives to foster the network could enhance the benefits created thanks to the TTTDM. It is therefore very crucial to keep the links created during the TTTDM and foster them to develop future actions.

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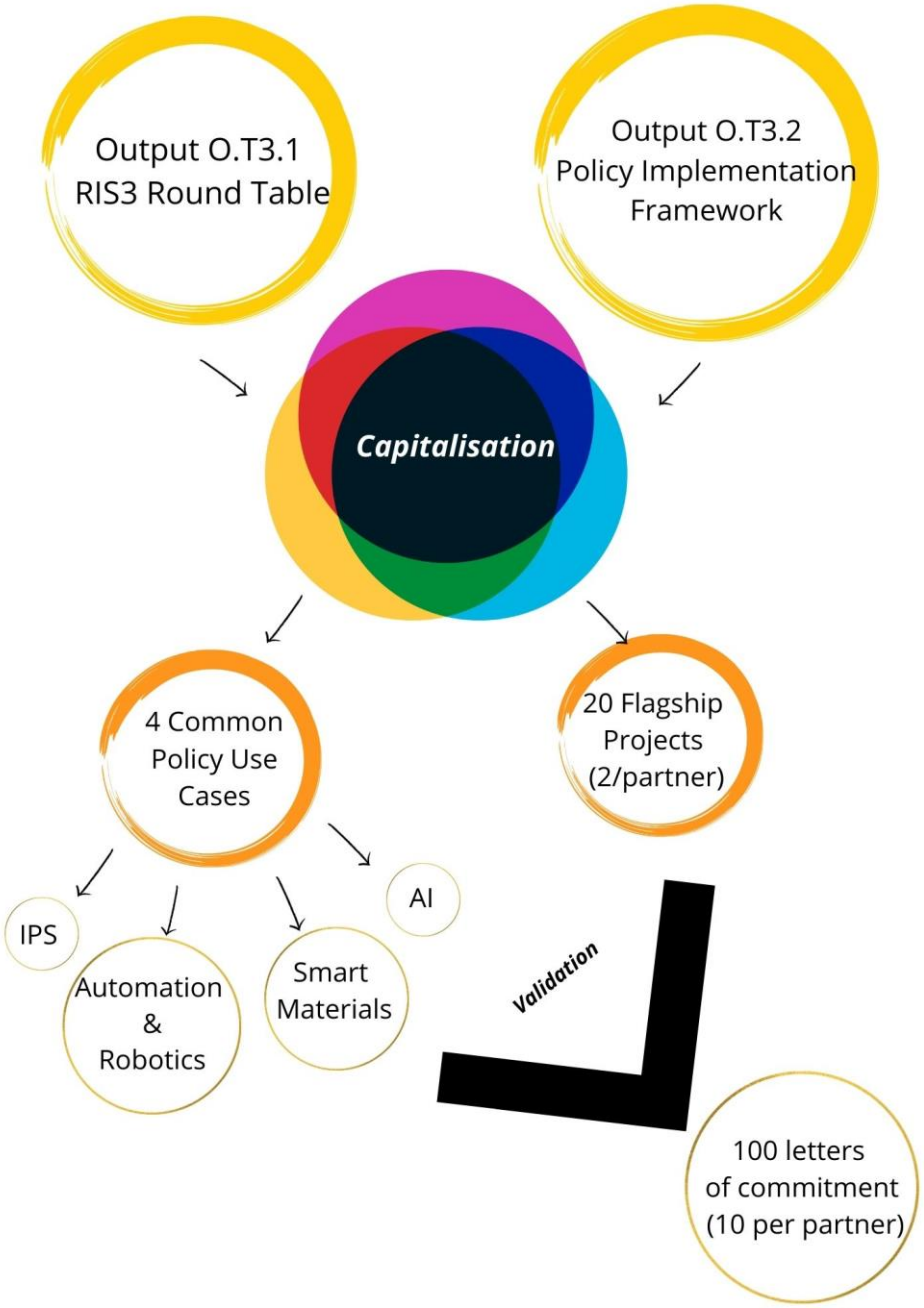

Figure 22 Overview of WPT3 (Source: DT.3.3.1, CEUP2030, 2021)

To build the Common Policy Use Case as part of WPT3 activities, not only should the members of the S&A Material TIN look at the TTTDM results and other flagships but also acknowledge each other resources and capabilities. These resources and competencies have been summarized in the table below:

Table 14. S&A Materials TIN Strengths & Resources (Source: DT1.3.3, CEUP2030, 2020)

Partner Name	Resources and Capabilities for S&A Materials	Strengths and Competencies for S&A Materials
IWU	• Broad offers and project activities in the smart3 network focussing on interdisciplinary co-working and	• Connecting network partners, matchmaking and acquisition competence

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	deep dive into smart structures and application possibilities: ○ 19 finished network projects ○ 23 approved network projects ○ 12 new projects in the application process • Connecting experts with specific know-how and offering workshops and advanced trainings for network partners and externals • Conception of a smart material lab	• Analysis of technological trends • Industry & Research Project Weeks and other educational and communicative offerings • Organisation and content- related enrichment of national and international workshops, presentations and forum participations
KPT	• DIH KPT – hub4industry • ScaleUp accelleration programme • Network and ecosystem at the regional and transnational level • Connection with experts, scientists, innovative start-ups, large enterprises	• Expertise in Industry 4.0 topics • Project management competencies • Experience in supporting the development of innovative technologies
AFIL	• Awareness creation and innovation scouting: organization of meetings and events in the field of Production System, mainly thematic workshops for increasing awareness on the topics involving key players of the network. • Road mapping: identification of stakeholders needs and priorities in the field of Production System • Regional and Interregional ecosystem Building and networking on the topic. • Facilitate access and connection with innovation infrastructures, mainly from core players in the regional and interregional AFIL network, both industrials and academia. •	• Consolidated network of expert from different fields that offer their knowledge and competences in an open innovation environment • Direct or indirect dialogue with institutions of different levels. • Experience in many cooperation projects addressing this topic, generating new insights for the regional network • Foster the dialogue and interaction between SMEs and large enterprises, creating mutual benefit
SIIT	• Many connections with French and Italian stakeholders who might be interested.	• SIIT is part of ALLIANCE project which focus on textile application connected to the defense sector.

Moreover, it is crucial that the partners acknowledge and foster the sub-topics raised all along this report. These sub-topics are sorted out from the most popular ones in the TTTDM to the less:

- Smart Structures & Systems
- Functional printing
- Process-related sensor technology

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- Smart Materials Network

These subtopics should be fostered to define the Common Policy Use-Case. Finally, the Common Policy Use Case should acknowledge the SWOT made regarding the S&A Materials sector:

Table 15. SWOT on S&A Materials CAMI 4.0 Topic (Source: DT1.3.2, CEUP2030, 2020)

Strengths	Weaknesses
1. Experience of partly extensive project work with smart materials and their applications 2. Broad scope of projects: production technologies, lifestyle, architecture and mobility 3. Access to partnerships, connections and (interdisciplinary) networks 4. Material development facilities existing 5. (Manufacturing orientation and number of manufacturing companies addressable 6. Closeness to the market, knowledge about the areas in which the developments have to go to 7. Lots of basic research available	1. More knowledge about the materials needed 2. Limited capacity to influence policy makers. 3. Limited access to funding 4. Limited in-house capacities 5. Missing commercialisation strategies
Opportunities	**Threats**
1. Establish new co-operations in the field of smart materials resulting in fruitful project proposals 2. Connect through DIH on a European level 3. It is a concrete topic, which can be easily communicated to businesses, and thus, there are good recruitment possibilities (vast amount of use cases and tangible projects that can be useful for them). 4. Labs and testing infrastructure are in place 5. 3D and 4D printing opportunities 6. Recent and inspiring hype of the topic which open interesting use case applications 7. Diversity of the topic (Application areas: medical/textile...)	1. Slowdown in fostering actions or decreased action efficiency due to the current COVID- 19 situation. 2. Difficulties to achieve a sufficient number of target indicators. 3. High investment and development costs. 4. Patent protection can be an issue. 5. Unpredictable development time. However, development time is crucial to reach the properties to commercialize. 6. Standardization needs to find the right application → high research investment can lead to miss the hype cycle. 7. Dependency on public funding.

All of this knowledge should enable the TIN Smart Materials flagship group to define and implement their flagships projects and to define their Common Policy Use Case aimed at strengthening the Central Europe Ecosystem around Smart and Advanced Materials solutions.

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6. Conclusion and Next Steps

6.1. Conclusion

To conclude, this report showcases the added value brought by the implementation of the 10 TTTDM on the topic of S&A Materials. Therefore, the purpose of this document was the reporting of the TTTDM in S&A Materials, aimed at creating and fostering a common understanding of the ecosystem in Smart Materials solutions. Particularly, the TTTDMs organized by PPs have been detailed in terms of methodology, participating stakeholders, outcomes, and lesson learned.

In summary, 265 stakeholders from 7 countries were involved in expert workshops on the CAMI 4.0 Topic S&A Materials. The workshops were held mainly online except two (IWU and HAMAG), and utilised plenary presentation, roundtables, and Q&A sessions which allowed live discussion on the current and future trends, the current needs and challenges, and the opportunities offered by the ecosystem. The experts mainly from Business and Research Centres provided insights on the development on innovative solutions. The TTTDM's validated that the sub-topics chosen by the partnership are relevant for the future of S&A Materials. In one area – Smart Material Network – there was less interest from the stakeholder community, however this could also be a great opportunity to foster it through further actions and may be through the definition of the Common Policy-Use Case as all the partners acknowledged the need to enhance exchanges by the implementation of regular TTTDM or at least regular exchanges between stakeholders. Moreover, this last sub-topic, represents a great interest for IWU, which is the leader of this CAMI 4.0 topic.

6.2. Next Steps

Partners need first to acknowledge the benefits raised to develop Smart Materials technologies thanks to the TTTDM, the definition and submission of their flagships and the exchanges especially with the S&A Materials TIN.

They now have to engage in strong discussions within the TIN to commonly define their Common Policy Use Case. This Common Policy Use Case should emerge from common understanding of the needs and challenges raised during the TTTDM and the definition of the flagship projects. This common Policy Use Case should also have the role of strengthening the network around S&A Materials solutions.

If your organisation is interested to collaborate with the TIN on Smart & Advanced Materials, please contact the TIN Leader, Fraunhofer IWU to learn how to get involved. You can also contact the Lead Partner, Krakow Technology Park, and follow CEUP 2030 on its social media channels (LinkedIn) and its website, to learn more about what the other TINs are doing to advance Advanced Manufacturing and Industry 4.0 in Central Europe.

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7. Annex

TTTDM Reporting Template	
Name of the PP	Choose your PP Name
TTTDM Type (CAMI4.0 topic, regional/interregional), Date and Location	[Free Text Response]
Description of the TTTDM	[Free Text Response]
Methodologies applied in the TTTDM and description of the methodologies	[Free Text Response] 1) 2) 3) …
Which technologies and/or applications were discussed in the TTTDM?	
How many stakeholders participated in the TTTDM?	
Which Triple Helix stakeholder group did the participants belong to? (add number of participants)	___ policy ___ research ___ business ___ Supporting Organisations
Which EU project(s) was synergically involved in the TTTDM, if any?	

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Key Outcomes of the TTTDM and description	
Which lessons learned do you have as a project partner (a) and which lessons learned emerged for participants (b)?	
Hyperlink to picture and video content of the PLL	
General Summary of the TTTDM	

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