DiMAT

Holistic digital transformation of the SMEs manufacturing industry

D2.1 PROJECT VISION

31/03/2023

Digital Modelling and Simulation for Design, Processing and Manufacturing of Advanced Materials

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D2.1 Project Vision

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Abstract	This document aims to provide a clear and concise overview of the DiMAT Project Vision, serving as a reference guide for all partners involved in the project. It is designed to ensure that everyone remains focused on the main objectives and goals, while keeping all performed tasks in synchronization with the overall idea of the project. In addition, the document includes an initial risk table that itemises general inherent risks of innovation activities. This document can be used by partners as a source for creating presentations, deliverables and other documents for presenting DiMAT to external stakeholders.
Keywords	GUIDELINES, DIMAT PROJECT VISION, OBJECTIVES AND GOALS, PROJECT OVERVIEW, RISK TABLE, PROJECT STRATEGY

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0.3	02 -Mar-2023	Section 3.3 & 4 revised, Deliverables Map inserted and explained	NTP, ACCELI, HEGLA, TECHNORED, CETCOMP, IMERYS, AITEX, F6S, DIN, UPV
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EXECUTIVE SUMMARY

The DiMAT project aims to develop Open Digital Tools with a set of advanced technologies for offering European SMEs and Mid-Caps an affordable (in terms of cost, implementation and usability) full modelling, simulation and optimization system in each stage of the material value chain (design, processing and manufacturing) for improving quality, sustainability, effectiveness and competitiveness of materials. DiMAT will deploy 3 integrated Suites: 1) DiMAT Data and Assessment Suite: digital technologies for storing, sharing, representing and assessing materials data; 2) DiMAT Modelling and Design Suite: digital technologies for material design, in terms of their internal structure, properties and performance, in order to predict the material behaviour before manufacturing; 3) DiMAT Simulation and Optimization Suite: digital technologies for creating efficient materials manufacturing simulation processes and determining the behaviour of the material mechanical characterization models to be used in the AI training and prediction. The DiMAT Suites will be demonstrated in 4 Pilots of European designers and producers of different materials: textile, composite, glass and graphite.

The DiMAT Project Vision (D2.1) is a comprehensive reference document generated as a deliverable from Task 2.1. This guide will serve as the central source of information for all project partners and help them remain focused on the main objectives and goals of the project. The document will also help in maintaining the synchronization of all internal tasks with the overall project vision, as defined by the GA and DoA. It can be used by partners as a source for creating presentations and other deliverables for third parties, providing them with a preliminary overview of the project. The document also contains an upgraded initial risk table from the DoA that outlines the general inherent risks associated with innovation activities.

The deliverable consists of the following sections. The Introduction provides a brief overview of the document and its contents. The Elevator Pitch section offers an executive summary of the DIMAT Project and its results, providing a clear and concise explanation of the concept in a way that is easily understood. The Overall Concept section positions the project in terms of its business, research and technological objectives, as well as use case scenarios. The Strategic Positioning section characterizes the project within its context, including business opportunities, stakeholders, project commercialization and the contribution of DiMAT results. The Project Results section summarizes the DIMAT solutions and standardization activities. The Milestones and Deliverables section provides tables detailing the project milestones and deliverables. The Risks section presents the critical implementation risks and mitigation actions for the DiMAT project. Finally, the Conclusions section summarizes the Project Vision Document.

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ABBREVIATIONS

EMMC	European Materials Modelling Council
MODA	Modelling Data
CHADA	Characterization Data
OSP	Open Simulation Platforms
CUDS	Common Universal Data Structures
SMEs	small and medium-sized enterprises
KPIs	Key Performance Indicators
SoA	State of the Art
WP	Work Package
FEA	Finite Element Analysis
AI	Artificial Intelligence
ICT	Information and Communications Technology
API	Application Programming Interface
LCA	Life Cycle Analysis
UAVs	Unmanned Aerial Vehicles
PP	Polypropylene
PET	Polyethylene terephthalate
KPI	Key Performance Indicator
ERP	Enterprise Resource Planning
ML	Machine Learning
IPR	Intellectual Property Rights
CRL	Customer Readiness Level
EoI	Expression-of-Interest

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PDCER	Plan for Dissemination, Communication & Exploitation of Results
KERs	Key Exploitable Results
CV	Curriculum Vitae
SaaS	Software-as-a-Service
IP	Intellectual Property
TRL	Technology Readiness Levels
ISO	International Organization for Standardization
CEN	European Committee for Standardization
IIRA	Industrial Internet Reference Architecture
RAMI4.0	Reference Architecture Model for Industrie 4.0
IDSA	International Data Spaces Association
IMSA	Industrial Manufacturing and Service Architecture

1 INTRODUCTION

The European society and industry are undergoing a historic transition, as it moves towards a greener and more digitally transformed future. With the global warming crisis and the impact of recent events like the pandemic, there is an urgent need for sustainable and resilient systems to become the norm. Despite the progress made in digital transformation in the manufacturing industry, the integration with material science and engineering is still lagging behind. This is especially significant considering that material costs form a large portion of production costs.

To overcome this challenge and drive material-based innovations, a comprehensive digital transformation of the manufacturing industry is necessary. This requires access to high-quality, efficient, cost-effective and optimized systems, including cloud infrastructure, model- and simulation-based twin technologies and data-driven approaches. The European Materials Modelling Council (EMMC) and the European Material Characterization Council (EMCC) have devised a strategic plan to enhance the benefits of computational tools for small and medium-sized enterprises (SMEs). The plan includes the development of MODA (Modelling Data) and CHADA (Characterization Data) for systematic and traceable representations, as well as Open Simulation Platforms (OSP) and Common Universal Data Structures (CUDS) to support interoperability.

Advanced materials hold the potential to outperform traditional materials and lead to the creation of entirely new products, making them critical to the future success of the European manufacturing industry. Realizing this vision requires collaboration between modellers, materials data scientists, software owners and translators, as well as access to the necessary tools.

The DiMAT Project aims to address these needs, by offering open-source digital tools to SMEs and mid-caps. These tools will be based on open standards such as MODA and CHADA and the EMMO ontology, providing companies with the necessary modelling, simulation and optimization functionalities throughout the material value chain. Additionally, the DiMAT Suites will be offered as a cost-effective cloud-based software-as-a-service (SaaS), without the need for high upfront investments or IT skills. The DiMAT Toolkits will be tailored to the unique needs of SMEs and mid-caps, providing advanced knowledge-based tools to improve their material design, processing and manufacturing processes. This will allow these companies to more effectively and quickly respond to market changes and increase their competitiveness.

By linking simulation-based twin technologies and fostering collaboration between stakeholders, the DiMAT Project will play a key role in driving a holistic digital transformation of the European manufacturing industry. This will lead to material-driven innovations and the development of new products, helping to achieve a sustainable and resilient future

2 ELEVATOR PITCH

The DiMAT Project will develop three DiMAT Suites, each consisting of three toolkits, resulting in a total of nine toolkits that compose the exploitable results of the project.

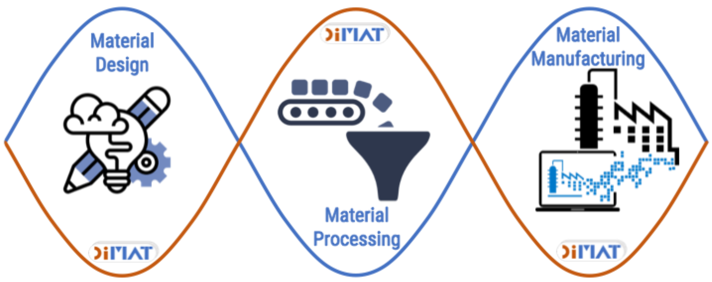

Figure 1: DiMAT Concept

The DiMAT 3 Suites are analysed in the following:

- The DiMAT Data and Assessment Suite is a set of digital tools powered by semantic technologies that provide data storage, management and utilization solutions. It consists of three tools: the DiMAT Cloud Materials Database (DiCMDB), the DiMAT Knowledge Acquisition Framework (DiKAF) and the DiMAT Materials Environmental and Cost Life Cycle Assessment (DiMEC·LCA). These tools work together to offer a centralized repository for materials data, enable knowledge acquisition and assess materials based on their environmental impact and cost over their life cycle.
- The DiMAT Modelling and Design Suite is a set of digital technologies for material design that allows for prediction of material behaviour before manufacturing. It consists of three tools: the DiMAT Materials Design Framework (DiMDF), the DiMAT Materials Modeler (DiMM), the DiMAT Materials Designer (DiMD). These tools work together to enable material design in terms of internal structure, properties and performance.
- The DiMAT Simulation and Optimization Suite is a set of digital tools for material manufacturing simulation and material behaviour prediction. It includes the DiMAT Materials Mechanical Properties Simulator (DiMMS), DiMAT Materials Processing Simulator (DiMPS), DiMAT Digital Twin for Process Control (DiDTPC). These tools work

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together to create efficient simulation processes and determine the behaviour of mechanical characterization models for use in AI training and prediction.

DiMAT Data and Assessment Suite	DiMAT Modelling and Design Suite	DiMAT Simulation and Optimisation Suite
DiMAT Cloud Materials Database	DiMAT Materials Design Framework	DiMAT Materials Mechanical Properties Simulator
DiMAT Knowledge Acquisition Framework	DiMAT Materials Modeler	DiMAT Materials Processing Simulator
DiMAT Materials Environmental and Cost Life Cycle Assessment	DiMAT Materials Designer	DiMAT Digital Twin for Process Control

Figure 2: DiMAT Suites

DiMAT Data and Assessment Suite (Di^{DAS}):

- DiMAT Cloud Material Database (**Di**^{CMDB}),
- DiMAT Knowledge Acquisition Framework (**Di**^{KAF}),
- DiMAT Materials Environmental & Cost Life Cycle Assessment (**Di**$^{MEC\text{-}LCA}$)

DiMAT Modelling and Design Suite (Di^{MDS}):

- DiMAT Materials Design Framework (**Di**^{MDF}),
- DiMAT Materials Modeler (**Di**^{MM}),
- DiMAT Materials Designer (**Di**^{MD}),

DiMAT Simulation and Optimisation Suite (Di^{SOS}):

- DiMAT Materials Mechanical Properties Simulator (**Di**^{MMS})
- DiMAT Materials Processing Simulator (**Di**^{MPS})
- DiMAT Digital Twin for Process Control (**Di**^{DTPC})

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3 PROJECT OVERVIEW

The DiMAT project is poised to revolutionise the European materials industry by offering a cutting-edge set of advanced technologies through its Open Digital Tools. These tools will provide European small and medium-sized enterprises (SMEs) and mid-cap businesses with an affordable system for full modelling, simulation, and optimisation at every stage of the material value chain, from design to processing and manufacturing. By implementing these Open Digital Tools, the DiMAT project seeks to facilitate innovation and collaboration in the European materials industry, ultimately making it more competitive and sustainable.

To achieve these goals, the DiMAT Suites will be demonstrated in four pilots involving European designers and producers of various materials, including textiles, composites, glass, and graphite. These pilots will provide valuable insights and feedback to help refine and improve the DiMAT tools, as well as offer a tangible demonstration of the potential impact of the project on the European materials industry. By working together, the DiMAT project and its stakeholders aim to usher in a new era of digital innovation in the European materials industry that will enable it to remain competitive in the global marketplace.

3.1 OVERALL CONCEPT OF DIMAT

The overall idea of DiMAT is summarised in **8 specific objectives**, as stated in the Grant Agreement (GA). These objectives have been thoughtfully selected to guarantee that the project achieves its ultimate aims and provides the anticipated advantages upon completion. They are closely tied to the project's work packages, with each objective corresponding directly to one of the project's work packages.

- **O1:** To properly manage the project for guaranteeing that the project objectives are met by ensuring the successful completion of the project on-resource, on-quality on time. (**WP1**)
- **O2**: To develop and share among the different consortium partners and other stakeholders the DiMAT project vision, establish the SoA in terms of technologies for materials modelling, design, processing and manufacturing and to set the requirements driving the creation of the DIMAT toolkits. (**WP2**)
- **O3**: To design the DiMAT framework and deliver the DiMAT architecture for materials modelling, design processing and manufacturing and devised using multiple perspectives, related to business, usage, functional and implementation viewpoints. (**WP3**)

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- **O4**: To build the DiMAT Data and Assessment Suite, a central set of digital technologies for the data storage, data management and data usage driven by semantic technologies for enabling FAIR principles and Industry commons. (**WP4**)
- **O5**: To build the DiMAT Modelling and Design Suite, a set of digital technologies for designing materials in terms of their internal structure, properties and performance allowing them to predict their behaviour before manufacturing. (**WP5**)
- **O6**: To build the DiMAT Simulation and Optimisation Suite, a set of digital technologies creating efficient materials manufacturing simulation processes and determining through FEA the behaviour of the material mechanical characterisation models to be used in the AI training prediction. (**WP6**)
- **O7**: To test and validate the DiMAT toolkits in 4 use cases, materials manufacturers and industrial users covering different sectors (polymer, composite, glass, graphite). (**WP7**)
- **O8**: To disseminate the DiMAT toolkits providing an outreach of the project activity and results, paving the way for broad adoption of DiMAT toolkits in the industry. To create or contribute to standards compliant with existing and evolving ICT standards facilitating regulation and certification. To facilitate technology uptake and long-term adoption of the DiMAT toolkits by the material manufacturers and industrial users (**WP8**)

The **3 DiMAT Suites** will be designed to improve a comprehensive set of 21 Key Performance Indicators (KPIs) that are closely linked to the DiMAT solutions and aligned with the above project objectives, Table 1.

KPI	Key Performance Indicator	Toolkits	OBJ
KPI1	Improvement of material data safety	**Di^{CMDB} Di^{KAF}**	**O4**
KPI2	Improvement of material mechanical properties	**Di^{MMS}**	**O6**
KPI3	Improvement of material thermal properties	**Di^{MMS}**	**O6**
KPI4	Improvement of material traceability	**Di^{CMDB} Di^{KAF}**	**O4**
KPI5	Improvement of material designs	**Di^{MD} Di^{MM}**	**O5**
KPI6	Improvement of personnel training ROI	**Di^{MDF}**	**O5**
KPI7	Increase of material performance	**Di^{MPS} Di^{MMS}**	**O6**
KPI8	Increase of on-time completion	**Di^{DTPC}**	**O6**
KPI9	Increase of material operational characteristics	**Di^{MMS}**	**O6**
KPI10	Increase of personnel digital skills	**Di^{ALL}**	**O4 O5 O6**

KPI11	Increase of personnel productivity	Di^{ALL}	**O4 O5 O6**
KPI12	Increase of use of materials from renewable resources	$Di^{MEC\cdot LCA}$	**O4**
KPI13	Reduction of material design cost	$Di^{MEC\cdot LCA}$ Di^{MM}	**O4**
KPI14	Reduction of material design errors	Di^{MDF} Di^{MD} Di^{MM}	**O5**
KPI15	Reduction of material during designing and modelling	Di^{MM} Di^{MD}	**O5**
KPI16	Reduction of material economic impact	$Di^{MEC\cdot LCA}$	**O4**
KPI17	Reduction of material environmental impact	$Di^{MEC\cdot LCA}$	**O4**
KPI18	Reduction of material for testing	Di^{MPS}	**O6**
KPI19	Reduction of material production cost	$Di^{MEC\cdot LCA}$ Di^{MPS} Di^{DTPC}	**O4 O6**
KPI20	Reduction of prototyping procedures	Di^{MMS} Di^{DTPC}	**O6**
KPI21	Reduction of time to market	Di^{ALL}	**O4 O5 O6**

Table 1: DiMAT Key Performance Indicators

3.2 IMPLEMENTING THE DIMAT CONCEPT

The DiMAT Framework will be described from multiple perspectives, including business, usage, functional and implementation viewpoints. This comprehensive approach will ensure that all relevant aspects of the framework are considered and integrated into the design. The DiMAT Architecture will then be developed, incorporating these various perspectives to support the entire material value chain, from design to processing and manufacturing. This holistic approach will provide a comprehensive and integrated solution that addresses the needs of all stakeholders across the material value chain.

1. The business viewpoint in the DiMAT Framework will be comprehensive, capturing not only business, regulatory and stakeholders' perspectives, but also analysing the business requirements and potential new business models to be supported by the DiMAT architecture. This multi-faceted approach will ensure that the DiMAT solution addresses the needs and requirements of all stakeholders and is in line with the current and future business landscape.

2. The usage viewpoint aims to identify the key elements of the DiMAT framework such as tasks, roles, activities and parties, taking into account both human beings and software systems. It will then define the functional map and implementation maps, specifying the role responsible for executing the tasks. The objective is to ensure an optimal usage of the framework and guide the implementation of the DiMAT Suites

by defining the roles and responsibilities, workflows and organization of activities in the framework.

3. The functional viewpoint will aim to decompose the DiMAT Framework into its control, operations, information, application and business domains and to identify the data, decision and command/request flows circulating among them. It will then elaborate on the controls, coordination and orchestration exercised from each of these domains, as well as on the different typical operations from these domains, to provide a comprehensive description of the functioning of the DiMAT Framework

4. Finally, the implementation viewpoint will deliver a technical specification of the DiMAT architecture, including its components and their interconnections, required technologies and APIs. It will consider the results of the business viewpoint and usage viewpoint to provide implementation maps and a detailed architecture based on cloud computing patterns, such as edge computing and microservices.

To carry out the developing of the DiMAT Suites, the project will adopt a product life cycle-inspired approach that emphasizes the utilisation and reutilisation of available applications and technologies. The work will be carried out in various work packages that are interdependent and categorized according to their purpose: need, design, build, evaluate, impact, and manage. These interdependencies are illustrated in Figure 3, with each work package color-coded according to its category. The following are the key aspects of how the DiMAT Project will implement its solution and achieve its objectives:

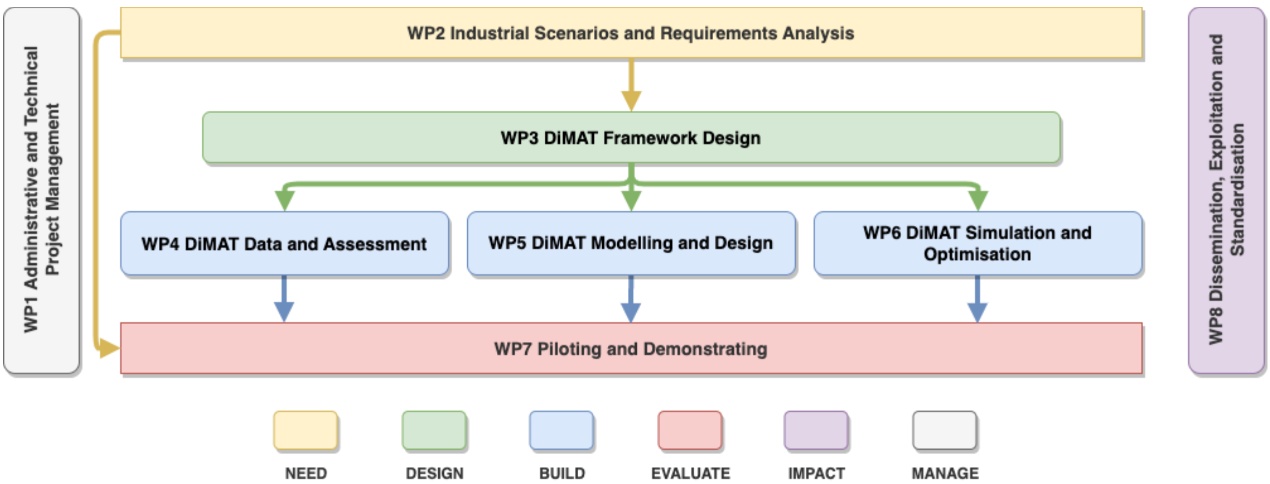

Figure 3: Interdependencies among the different DiMAT work packages

NEEDS (WP2): To synchronise the project vision and offer a comprehensive summary for the intended audience, conduct a multidimensional evaluation of current technologies for

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materials modelling, design, processing and manufacturing and to capture the needs from industry to be satisfied by the project outputs.

DESIGN (WP3): To provide the DiMAT Framework based on a clear and detailed DiMAT Architecture and to describe it using multiple perspectives: business, usage, functional and implementation.

BUILD Data and Assessment (WP4): To build the Data and Assessment Suite that leverages digital technologies for efficient data storage, management and utilisation. The Suite will utilise semantic technologies to ensure semantic interoperability and provide high-level assessment through advanced data visualisations

BUILD Modelling and Design (WP5): To build the Modelling and Design Suite, which utilises AI and analytical processes to anticipate material behaviour prior to manufacturing. It also enables a streamlined material design process that considers internal structures, properties and performance. The Suite leverages ontology-based knowledge to support material design and uses causal inference to clarify intricate correlation patterns among interrelated phenomena.

BUILD Simulation and Optimisation (WP6): To build the Data and Assessment Suite that leverages digital technologies for efficient data storage, management and utilisation. The Suite will utilise semantic technologies to ensure semantic interoperability and provide high-level assessment through advanced data visualisations

VALIDATE Demonstration (WP7): To demonstrate and validate the DiMAT Solutions:

1. **Synthetic Textiles Production:** To demonstrate the impact of DiMAT Solutions for supporting the development of new polymers and other materials in the manufacturing industry.

2. **UAVs Manufacturing with Advanced Composite Materials:** To demonstrate the potential of DiMAT Solutions in enhancing the performance of unmanned aerial vehicles (UAVs), while reducing costs and minimising their environmental impact.

3. **Innovative Glass Forming Process in Digital Environment**: To demonstrate the impact of DiMAT Solutions for improving materials development and production processes through the use of simulation and modelling tools and by providing a comprehensive database of materials properties

4. **Speeding-up the New Product Development Process:** To demonstrate the potential impact of the DiMAT Solutions, highlighting how the digital toolkits can

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improve product development, process and application development, and LCA analysis

DISSEMINATE Dissemination and Standardisation (WP8): To ensure a significant impact, putting the project on the reference map of relevant industries, research communities, and policy makers, the dissemination activity will promote the adoption of DiMAT toolkits to improve material life cycle efficiency, reduce environmental impact, and foster a sustainable and competitive economy. In addition, the activity will also focus on effective market exploitation and widespread standardisation of the project results.

MANAGE Management (WP1): To guarantee successful project management activities and ensure on-time and on-definition project delivery. The DiMAT consortium is made up of 18 participants with different roles covering all the areas of expertise and demonstration necessary for a correct execution of the project. The following is the list of all stakeholders grouped by their role in the project:

- Industrial partners (USER): NTP (Renewable Plastic Compounds), ACCELI (Unmanned Aerial Vehicles), HEGLA (Glass Manufacturing Processes), TECHNORED (Melt Spinning Company), CETCOMP (Composite materials), IMERYS (Graphite and Carbon Black)
- Technology providers (TECH): CETMA (Research and Technology organization), DRAXIS (Environmental Technologies), AMS (Advanced Material Simulations), ROPARDO (Digitalization Solutions and integration)
- Research & development (R&D): UPV (Technical University), Fraunhofer (Applied research organization), AITEX (Textile research institute), NTUA (Technical University), SUPSI (University of Applied Sciences), CERTH (Research Institute)
- Specialist Companies: F6S (Dissemination and Exploitation), DIN (Standardisation)

3.3 CASE STUDIES

The DiMAT project will demonstrate its results in four pilot use cases that represent four relevant material production scenarios. These scenarios will be explored in T2.3 and fully implemented and evaluated in WP7. The case studies will summarize the context and situations prior to and following the implementation of DiMAT Solutions, along with an estimate of the enhancements in the KPIs outlined in Table 1. The pilots will be implemented under real-world conditions to show the applicability and impact of the project and its results. This will help to validate that the technology readiness level of the tools implemented are at least at level 6.

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3.3.1 Pilot 1: Synthetic Textiles Production

Context: NaturePlast SAS (NTP) produces and markets innovative renewable plastic compounds that address problems not resolved by current biosourced or biodegradable and unprocessed compostable plastics. The compounds are composed of various biosourced and/or biodegradable polymers, additives and other components that improve mechanical properties, thermal stability and lifespan. On the other hand, Tecnología Redera SL (TECNORED) is a manufacturer of a wide range of fishing nets, construction safety nets, threads and ropes. NTP, as the polymer formulation producer, prepares and tests new formulations that incorporate functional and nanoadditives for processing companies such as TECNORED (a melt spinning company). The aim is not only to prepare new formulations, but also to ensure that the new compounds are processable downstream by the companies in charge of processing the polymers into final products. In this sense, the spinning companies (producers of synthetic filaments like PP and PET) must use formulations that not only provide new functionality to the products, but also have proper processing features such as good rheology in the molten state and the absence of agglomerates in the polymer formulation.

Figure 4. Synthetic Textiles Production

Before DiMAT: Currently, compounding production is done through a trial-and-error method which incurs high costs in terms of production and laboratory testing. Producers create new polymers by adding nanoparticles and additives to achieve compounds with improved properties such as mechanical stress, light fastness and colour fastness. However, this is based on the producer's experience or previous research with no guarantee of success after validation in laboratory tests. When these compounds are delivered to synthetic yarn producers, another validation is required, as the extrusion process of the compound pellets may affect the properties of the polymer. Finally, when the final product is produced, such as a fishing net or a construction safety net, it must undergo a final test to ensure that it meets the established requirements. For example, a new fishing net must pass several validation tests for fastness and construction safety nets must pass mechanical stress tests. In these cases, the polymers suffer different mechanical processes that affect its properties, not only from the melting (high temperature) or extrusion process, but also from the process of a net manufacturing, where knot making processes generate a stress concentration in specific areas where the net can break.

After DiMAT: DiMAT will support the development of new polymers and other materials in the manufacturing industry. The DiMAT Materials Designer (MD) will be used to design new polymers and the DiMAT Materials Processing Simulator (MPS) will simulate the production process, allowing cost reduction and improving the generation of new compounds. The simulation will provide a high level of certainty for companies to invest in the development of a new product.

DiMAT will also assist synthetic yarn producers and spinning companies in simulating their products and production processes, ensuring that their products meet the required specifications before manufacturing. The simulation will help to understand the behaviour of the polymer material during the compounding, extrusion and spinning processes for producing filaments, which will be used to make threads, ropes and nets with the desired mechanical and thermal properties, light fastness and so on.

The simulation and modelling activities will be further validated with real tests (e.g., rheology, dispersion of additives, filter tests, mechanical properties, etc.) and compared with the results obtained by the DiMAT Materials Mechanical Properties Simulator (MMS). After the simulations are done, a validation process and material testing will be conducted during the development and execution of the pilots to verify that the results match the simulation outcomes.

[KPI6 +10%] [KPI7 +25%] [KPI13 -40%] [KPI15 -30%] [KPI18 -50%] [KPI21 -45%]

3.3.2 Pilot 2: UAVs Manufacturing with Advanced Composite Materials

Context: Acceligence LTD (ACCELI) is a Cyprus-based company specializing in cutting-edge R&D activities aimed at boosting innovation capital, enhancing products and aligning services with the latest technological advancements. The company has been focusing its efforts on the development of Unmanned Aerial Vehicles (UAVs), haptic technology and other robotic solutions. ACCELI is currently manufacturing its own UAV prototypes, each with unique characteristics designed to meet the diverse needs of various industries, leveraging the latest advancements in AI and Robotics Engineering.

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Cetma Composites Srl (CETCOMP) is an innovative SME that leverages the multiannual expertise of CETMA Research Centre, a non-profit research centre with 27 years of experience in material studies, processes, techniques and methods. CETCOMP's mission includes the production and sale of composite materials for sports, furniture, leisure and aerospace industries. CETCOMP is ACCELI's main supplier and CETMA is becoming a leading reference for companies seeking to invest in composite material innovation, with a particular focus on out-of-autoclave technologies. The research centre has 4,000 square meters of laboratory and office space and employs 80 researchers, engineers, designers and project managers.

The study for the pilot case will begin with the definition of requirements from ACCELI, with a focus on defining the key considerations for innovative composite structures for drones, including weight, cost, mechanical properties and physical properties. The results of this activity will guide the rest of the R&D activities.

Figure 5. UAVs Manufacturing with Advanced Composite Materials

Before DiMAT: Currently, ACCELI is relying on commonly used materials such as PLA, PVA, carbon fibre and aluminium spacers to construct its UAVs. The drone frame is mainly composed of flat carbon fibre sheets and arm mounts that also serve as structural parts, reinforced by aluminium spacers. Holes and slots are provided to install components and route cables. The arms of the UAV are designed in a Y configuration and feature a total of eight motor-propeller pairs. The arms are easily detachable for compact storage and transportation. However, the most crucial factor affecting the performance of a UAV is its weight and mechanical properties, which have a direct impact on its flight characteristics, duration and cost.

After DiMAT: The objective is to enhance performance, reduce costs and minimise the environmental impact of drone composite structures through the exploration of innovative material solutions and new technologies. This involves a comprehensive approach that integrates research and development activities and involves the collaboration between CETMA (Research Centre) and CETCOMP (innovative SME). The DiMAT Suites will be used to investigate the potential use of renewable and recyclable materials for drone structures. The DiMAT Materials Design Framework (MDF) and DiMAT Materials Modeler (MM) will be employed to design and evaluate these materials. The DiMAT Materials Designer (MD) will analyse requirements and identify the best solution and technology for the sub-components, utilising CETCOMP's composite processing technologies and CETMA's expertise in areas such as compression moulding, prepreg Ooa and resin transfer moulding. The DiMAT Digital Twin for Process Control (DTPC) will reduce environmental impact by monitoring key material processes in real-time and optimising them for efficiency. Analytical and numerical models will be utilised to optimise structures and processes. Quality will be determined through a prototyping phase and critical analysis of results, including performance analysis, Life Cycle Cost (LCC) and Life Cycle Assessment (LCA) using the DiMAT Materials Environmental and Cost Life Cycle Assessment (MEC-LCA).

[KPI5 +15%] [KPI9 +20%] [KPI12 +30%] [KPI17 -15%] [KPI19 -40%] [KPI20 -25%]

3.3.3 Pilot 3: Innovative Glass Forming Process in Digital Environment

Context: Hegla-Hanic GmbH (HEGLA) is a German company specializing in the development of digital tools for glass manufacturing processes, with a focus on logistics, ERP and control systems. They aim to use data-driven approaches and simulations to accelerate the innovative design and implementation of the glass forming process. The European glass forming industry is projected to grow at a yearly rate of 4.1% over the next five years and Fraunhofer has developed an innovative laser-based glass bending process that is highly energy-efficient and results in high-quality products. The new technology has the potential to lead to inventions in various fields such as civil engineering, architecture, car industry and consumer goods.

Before DiMAT: Conventional development and design of glass forming processes is a labor-intensive, time-consuming and resource-intensive process that requires a higher level of automation and sufficient knowledge of materials and experience with digital tools. To accelerate the process, Fraunhofer has developed a smart and cognitive glass bending machine that streams sensor data to a time-series database and integrates a simple Machine Learning (ML) model. However, due to the complexity of development and the thermo-mechanical properties of glass, some crucial elements such as a comprehensive knowledge base of glass materials, a fully automated process for collecting and processing data and more advanced simulation models are still lacking.

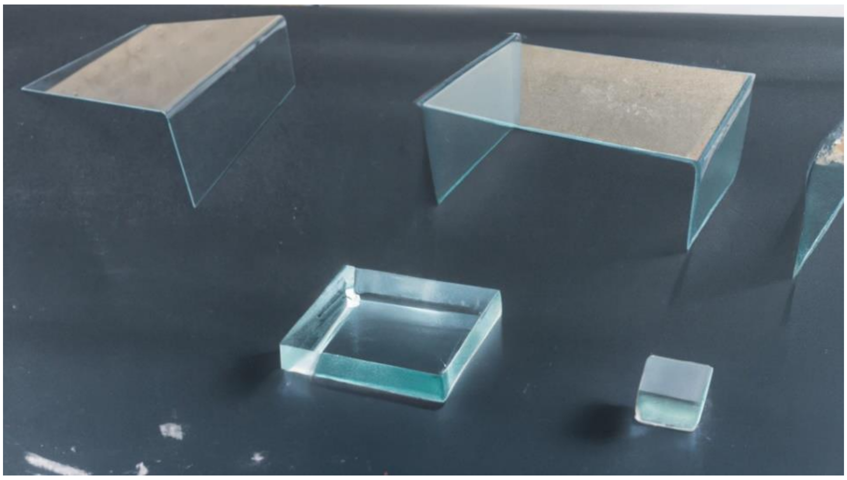

Figure 6. Innovative Glass Forming process

After DiMAT: The DiMAT project aims to improve materials development and production processes through the use of simulation and modelling tools and by providing a comprehensive database of materials properties. This will lead to cost reduction, better product quality and increased sustainability. The project will use various tools including the DiMAT Materials Designer (MD), DiMAT Materials Processing Simulator (MPS), DiMAT Materials Mechanical Properties Simulator (MMS), DiMAT Materials Modeler (MM) and DiMAT Digital Twin for Process Control (DTPC), as well as the DiMAT Cloud Materials Database (CMDB) and DiMAT Knowledge Acquisition Framework (KAF). Key performance indicators (KPIs) will be used to measure the success of the project, including improvements in data consistency and safety, thermal properties, material design, on-time completion of products, resilience against economic impact and reduction in prototyping procedures.

[KPI1 +30%] [KPI3 +10%] [KPI5 +20%] [KPI8 -30%] [KPI16 -30%] [KPI20 -40%]

3.3.4 Pilot 4: Speeding-up the New Product Development Process

Context: Imerys Graphite & Carbon is a Swiss company with a history of delivering high-tech carbon-based solutions to manufacturing and industry. They produce synthetic and natural graphite, as well as conductive carbon black for mobile energy applications. Their Technology and Innovation Centre in Bironico, Switzerland, studies the use of graphite and carbon across a range of applications, including primary and secondary batteries, fuel cells, polymers, brakes and clutches, carbon brushes, powder metallurgy and refractories. IMERYS is a global leader in innovative graphite and carbon-based solutions for sustainable mobile energy applications and invests significant R&D resources in the development of solutions for battery and energy storage technologies, with a team of 30 researchers and 3 R&D facilities dedicated to tailored and advanced solutions.

Before DiMAT: IMERYS's product development process is currently time and resource-intensive, requiring extensive sampling and testing campaigns to fully understand and specify the characteristics of final products and production processes. While their state-of-the-art Technology and Innovation Centre supports customer-driven R&D activities and collaborations, relying on physical samples increases costs and lead times. Although IMERYS is pursuing sustainability goals, LCA assessments of new products are not conducted systematically but only for limited cases or upon customer request.

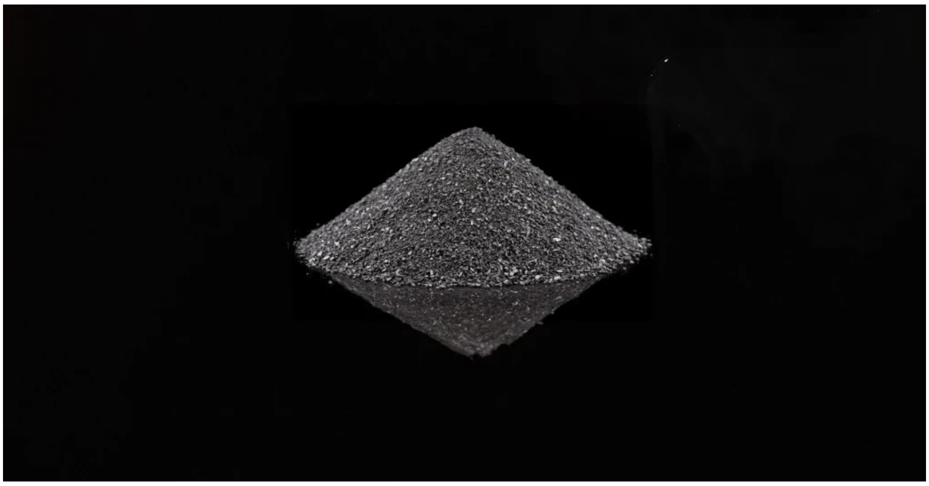

Figure 7. New product development process for Graphite

After DiMAT: The implementation of DiMAT Suites is expected to improve and expedite IMERYS's product development, process and application development, as well as obtain LCA information more efficiently and at lower costs. The DiMAT Suites will be user-friendly, allowing for easy use by vertical experts without extensive training. The DiMAT Materials Knowledge Acquisition Framework (KAF) will simplify data analysis and acquisition by characterizing and linking data through a Knowledge Graph (KG). The DiMAT Materials Modeler (MM) and DiMAT Materials Designer (MD) will speed up new product development and reduce the need for physical samples and application tests. The DiMAT Materials Processing Simulator (MPS) will help identify key process parameters on finished product characteristics and suitability for specific applications. The DiMAT Materials Environmental and Cost Life Cycle Assessment (MEC-LCA) will enable new product development managers to accurately consider sustainable impacts throughout the design process.

[KPI5 +15%] [KPI13 -20%] [KPI17 -10%] [KPI18 -50%] [KPI20 -30%] [KPI21 -30%]

3.4 EVALUATION

The evaluation process of DiMAT is structured in a 5-phase procedure. First, the DiMAT evaluation framework will be established to assess the toolkits on efficiency, agility and cost-benefit analysis. The toolkits will be tested and integrated with legacy systems before the full implementation of the solutions and the Suites. The Tool assessment and KPI validation will be conducted alongside the implementation activities, providing useful feedback to the tool implementation WPs. Finally, a roadmap with guidelines and recommendations will be developed based on the project's pilot experience and lessons learned.

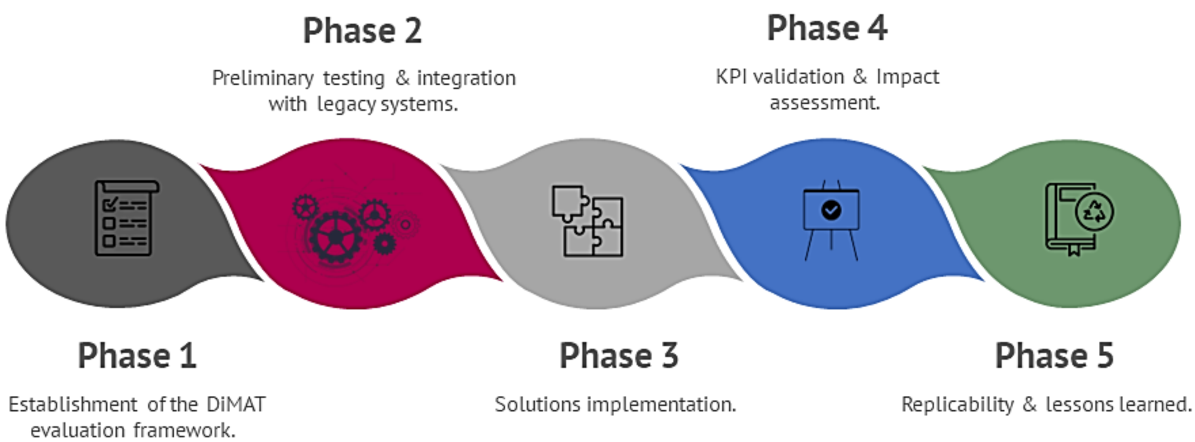

Figure 8: DiMAT 5-phase evaluation procedure

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4 POSITIONING

The DiMAT project aims to exploit the results of the project to achieve a successful commercial rollout. The exploitation activities will be guided by a tailored methodology based on the Customer Discovery Loop, with the goal of validating the desirability, feasibility and viability of the project's results. The key component of the exploitation strategy is the engagement of early adopters/end-users through expression-of-interest calls, focus groups, customer interviews and landing-page campaigns. The focus on end-user needs will ensure that the final products are well-adapted to the market and increase the chances of successful technology adoption. The exploitation methodology also includes a "willingness to sell" study to ensure the viability of the exploitation scenarios from the partners' point of view. The ultimate goal of the exploitation activities is to bring the results of the DiMAT project to a wider audience and support the commercial partners in exploiting the technologies developed within the project. The exploitation process will progress from hypothesizing on potential market needs to real market introduction, with the aim of increasing the customer readiness level throughout the project and reaching level 7, where customers are involved in extended product testing.

4.1 OBJECTIVES

The DiMAT Exploitation activities executed under WP8 will help partners in understanding what they are "in for" and reduce the risk for partners exploiting the project after the end of EU funding. The main goal is to facilitate connections and understanding of end-users' needs through a Customer Discovery Methodology and Customer Readiness Levels (CRL). The preliminary Business Model has been assembled based on feedback from partners and potential customers during the project proposal phase. The exploitation strategy will be tested through various experiments, such as Hypothesis Validation via Expression-of-Interest (EoI), Willingness to pay assessment of Early Adopters, Signature of Letters-of-Intent with early customers and Market Validation via a digital prototype. The Lean methodology allows for testing the exploitation strategy during the project and helps reduce the time and cost of bringing the DiMAT Suites to the market. The final Business Model will be validated via Value Creation Opportunity Mapping, and a dashboard will be used to review all processes and extract KPIs, IP issues, and financial simulations. This approach will help partners understand the commercial potential of the DiMAT solutions and reduce the risk of exploitation after the end of the project.

The main aim of the exploitation activities is to demonstrate the measures that will facilitate the commercial introduction of the DiMAT Toolkits in the materials value chain industry. It will be achieved by focusing on five objectives:

O8.1: To design and implement a powerful dissemination campaign for engagement with key stakeholders for a Plan for Dissemination, Communication & Exploitation of Results (PDCER).

O8.2: To ensure that knowledge is effectively disseminated and exploited within the participant organizations.

O8.3: To monitor and analyse the Intellectual Property Rights (IPR) positioning and, based on this, define potential IPR strategies.

O8.4: To develop a sound business plan to effectively support joint and individual commercial exploitation of results by the partners.

O8.5: To articulate a route to commercial access, tailored to the requirements of the partners and the industry's value chain.

4.1.1 Business Opportunities

The exploitation process in the DiMAT project begins with the preliminary Business Model, which is defined during the proposal preparation phase. This strategy will be continually assessed and revised throughout the project's execution using a lean methodology. The business model outlines the positioning of the KERs within the value chain and outlines associations with suppliers, customers, and collaborators for profit generation. The business plan converts this positioning into tactical actions and measures their financial implications. Figure 9 offers a summary of the Business Models employing the Lean Canvas method.

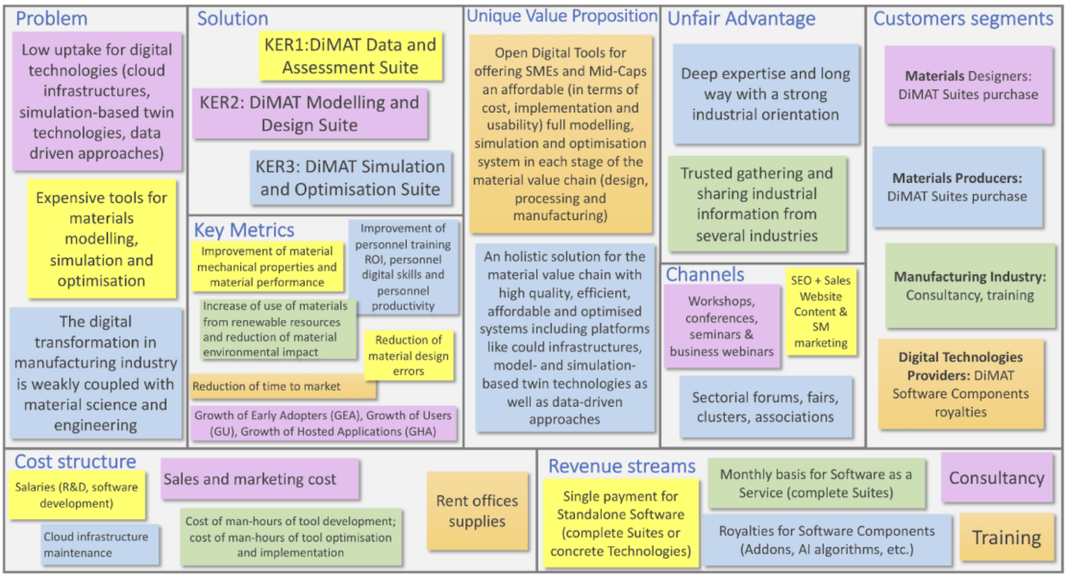

Figure 9: DiMAT Lean Canvas.

Following the overview of the exploitation process in the DiMAT project and the utilisation of the Lean Canvas method, three key aspects emerge, as outlined in the Grant Agreement (GA):

- Lean Canvas: At this stage, a first Lean Canvas for each KER has been created with feedback from consortium partners and potential customers gathered during the proposal phase.
- Hypothesis on the most adequate Exploitation Strategy: The consortium's envisioned joint exploitation strategy is uptake by commercial partners such as Fraunhofer, CETMA and AMS to bring the DiMAT Suites to market. The strategy is based on results from a survey among all project partners, specifically targeting the KER owners.
- Main integrated KER: The Customer Discovery Loop leads to the evolution of the Lean Canvas into a single Business Model encompassing all KERs.

4.1.2 Stakeholders

As a first step in the proposal stage, an initial stakeholder mapping was conducted for the DiMAT project, as referenced in the Grant Agreement (GA). This mapping identified various stakeholder groups that are expected to benefit from the project outcomes, including industrial sectors participating in the DiMAT pilots, other industrial sectors, technology providers, integrators, and standardisation bodies. A more detailed and comprehensive stakeholder analysis will be included in the dissemination deliverable, as part of ongoing efforts to engage with and address the needs of all relevant stakeholders.

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- The **European Materials Designers** is the primary target group, they will benefit from the results of the **DiMAT** Project by using the **DiMAT Digital Technologies** for improving quality, sustainability, effectiveness of materials from design. Ceramic Tiles Manufacturers will be able to use the **DiMAT Simulation and Optimisation Suite** to determine the pyroplastic behaviour. Composite Prepreg Manufacturers will be able to use the **DiMAT Modelling and Design Suite** to define the prepreg properties. Compounding Industry will be able to use the **DiMAT Data and Assessment Suite** to find the compound required among a great number of different formulas. Machine Tools Manufacturers will be able to use the **DiMAT Simulation and Optimisation Suite** to predict the material strength. Polymer Designers will be able to use the **DiMAT Data and Assessment Suite** to discover, evaluate and source the best materials for their projects. Sheet Moulding Compound Producers will be able to use the **DiMAT Modelling and Design Suite** to define the properties of the preform.

- The **European Materials Producers** is the secondary target group, they will benefit from the results of the **DiMAT** Project by using the **DiMAT** Digital **Technologies** for better process and manufacture advanced materials which outperform conventional materials and have far superior properties, such as increased toughness, hardness, durability and elasticity, leading, even, to the design of entirely new products y, therefore, increasing its competitiveness by offering materials of superior performance in one or more characteristics that are of high value for the manufacturing industry.

- The **European Manufacturing Industry** is the tertiary target group, they will benefit from the results of the **DiMAT** Project by using advanced materials, designed and produced by the **DiMAT Digital Technologies**, better designed and produced, with optimised characteristics and the lowest possible environmental impact, in order to produce more competitive and sustainable products, contributing to the leadership of Europe in manufacturing. More specifically, the use of the DiMAT MEC-LCA tool will allow the monitoring of new materials' footprint to further support sustainable decisions during production, as manufacturers can take into account the environmental and economic impact of the available alternatives.

- The **Digital Technologies Providers** will benefit from the results of the **DiMAT** Project by providing hardware or software that connects to the **DiMAT Toolkits** thanks to their interoperability. Manufacturers of sensors, actuators and industrial equipment will be able to integrate the **DiMAT** technologies into their systems, facilitating their adoption by the manufacturing industry. Software companies, both in the field of data, algorithms and applications in general, will be able to connect their software to **DiMAT** technologies, providing added value to their customers.

- The Human Workforce of the **European Industry** will benefit from the advantages provided by the **DiMAT** increasing their training in the use of digital technologies and improving their competences. Consumers of products manufactured with materials produced the **DiMAT Suites** will benefit from improved quality and more competitive costs of manufactured products. The Trainees and Students will benefit from training in the **DiMAT Toolkits**, which will add value to their CVs.

The **DiMAT Community** aims to establish a lively and energetic network of engaged members, representing all pertinent stakeholders. The community will encourage interactions, knowledge exchange, and finding synergies among peers in the materials design, modelling, and simulation domains. Strategic issues such as determining a distinct objective for the community and devising a strategy to draw in and maintain users, must be taken into account while customising the community's online platform on the F6S Ecosystem.

4.1.3 Exploitation strategy

The DiMAT project will not only be focused on the development of its Key Exploitable Results (KERs) but also considers the exploitation efforts for each of the distinctive components/subsystems of the KERs. These subsystems have the potential to be commercialized as stand-alone products for other applications. An initial survey had been performed during the proposal phase which helped to gather information and identify the exploitation strategy, business opportunities, and type of protection for these subsystems.

The **exploitation strategy** for the DiMAT Toolkits has been carefully planned and will be executed by focusing on the two main options for commercialization. The software toolkits will be marketed as a standalone software product for customers who prefer to install and run the software on their own systems. Alternatively, the toolkits will be offered as a Software-as-a-Service (SaaS) product for customers who prefer to use the software over the internet without the need for installation and maintenance on their own systems.

The **business opportunities** for the DiMAT Toolkits are vast and diverse, as they can benefit a range of stakeholders in the materials value chain industry. For materials designers, the toolkits will provide the ability to create and customize new materials with a wide range of functionalities. Materials producers will benefit from the ability to optimize their production processes and reduce waste and costs. Digital technologies providers will be able to offer new solutions and services to their customers by integrating the DiMAT Toolkits into their offerings.

The **type of protection** for the DiMAT Toolkits is mainly open source, which will allow for widespread adoption and use of the toolkits in the industry. However, the project also includes punctual trade secrets to protect valuable intellectual property, including the proprietary algorithms and methodologies used in the toolkits.

As part of the commercialization effort, a continuous Intellectual Property (IP) monitoring procedure will be activated to protect and exploit the most important and IP-sensitive developments. Specific IP issues has been identified and addressed in the Consortium Agreement, with foreground knowledge belonging to the project partner who generated it and joint ownership for knowledge developed jointly. Access Rights for background will be available without royalty fees for carrying out tasks during the project, unless an alternative arrangement agreed upon before the Grant Agreement signature.

To achieve its commercialization objectives, the project will also focus on designing and implementing a powerful dissemination campaign for engagement with key stakeholders, ensuring that knowledge is effectively disseminated and exploited within participant organizations, and developing a sound business plan to effectively support joint and individual commercial exploitation of results by the partners. Additionally, the project will articulate a route to commercial access tailored to the requirements of the partners and the industry's value chain.

Overall, the DiMAT project is taking a comprehensive approach to commercializing its outcomes, with a focus on the DiMAT Toolkits as the KERs with the most potential, individual exploitation efforts, and continuous IP monitoring. By implementing effective dissemination, exploitation, and business planning strategies, the project aims to facilitate the commercial roll-out of the DiMAT Toolkits in the materials value chain industry.

4.2 IMPACT OF DIMAT RESULTS

As outlined in the Grant Agreement, the outcomes of the DiMAT project will contribute to the following areas:

TECHNOLOGICAL: DiMAT aims to accelerate the adoption of digital technologies by material designers and producers, improving the quality, sustainability, effectiveness, and competitiveness of materials. The project will build industry-ready digital tools using existing technologies and open-source software, including the DiMAT Open Cloud Materials Database and a modular digital twin concept. DiMAT will use AI-based solutions for advanced optimization workflows in manufacturing processes and will be based on established semantic technologies to enable semantic interoperability. The project will provide new services for the design of materials and manufacturing processes, enhance interoperability between materials science and manufacturing engineering, and contribute to a sustainable and resilient industry.

ECONOMIC: DiMAT aims to increase productivity, innovation capacity, resilience, sustainability, and global competitiveness of EU materials industries and manufacturing companies. The project will support the digitalization of the EU materials value chains through the development and implementation of a suite of tools, including the DiMAT Materials Environmental and Cost Life Cycle Assessment, the DiMAT Materials Processing Simulator, and the DiMAT Digital Twin for Process Control. These tools will help assess the sector's sustainability and resilience, reduce material production and design costs, and minimize waste. DiMAT will also support the transition to circular economy by promoting cross-sectorial cooperation along the materials value chain and providing SMEs with affordable digital tools to improve the quality, sustainability, effectiveness, and competitiveness of materials, paving the way for industrial digitalization.

SOCIETAL: DiMAT 's societal impact is to support a sustainable and resilient materials industry that contributes to the green transition while providing high-quality jobs and a skilled workforce. The project aims to accelerate the green transition by providing digital technologies for full modelling, simulation, and optimization in each stage of the material value chain, increasing work efficiency, flexibility, safety, and learning for human workers. By supporting the development of digital tools for the materials industry, DiMAT will enable workers to upgrade their skills and stay up to date with the latest trends and technologies, improving overall working conditions in the industry. The project will also contribute to the development of clean and environmentally friendly processes, minimizing the environmental footprint of the materials industry, and thus contributing to the industry's decarbonization. By promoting cross-sectorial cooperation and providing affordable digital tools, DiMAT will support the transition to circular economy and pave the way for industrial digitalization.

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5 PROJECT RESULTS

5.1 DIMAT SOLUTIONS

In terms of Technology Readiness Levels (TRL), the DiMAT consortium anticipates refining and improving their proprietary or existing products with a strong foundation (minimum TRL 4) and some commercial-grade offerings. As a result, all DiMAT Solutions (Table 2) should demonstrate a minimum TRL 7:

DiMAT Toolkits integrated in the DiMAT Suites	Code	OBJ	Leaders	Supporting Technologies	Start TRL	Final TRL
DiMAT Data and Assessment Suite	Di^{DAS}	O4	Fraunhofer			
DiMAT Cloud Materials Database	Di^{CMDB}	O4	Fraunhofer	OPTIMADE, ZDMP Storage, ZDMP Secure Authentication and Authorisation, i4Q Data Repository, Data Space Management System SimPhoNy based	4-5	7
DiMAT Knowledge Acquisition Framework	Di^{KAF}	O4	NTUA	ZDMP Data Acquisition, ZDMP Data Harmonisation Designer and Runtime, i4Q QualiExplore for Data Quality Factor Knowledge, i4Q Data Integration and Transformation Services, Neo4j graph database, Apache OpenNLP library	4-6	7
DiMAT Materials Environmental and Cost Life Cycle Assessment	Di$^{MEC\cdot LCA}$	O4	DRAXIS	i4Q Services for Data Analytics, i4Q Analytics Dashboard, ZDMP Application Builder, ISO - ISO 14040:2006 - Environmental management — Life cycle assessment — Principles and framework, ISO - ISO 14044:2006 - Environmental management — Life cycle assessment — Requirements and guidelines	4-5	7

DiMAT Modelling and Design Suite	Di^MDS	O5	CETMA			
DiMAT Materials Design Framework	Di^MDF	O5	Fraunhofer	SimPhoNy based built Knowledge Service, MarketPlace Platform, Oyster-OIE-Platfrom, ZDMP Application Builder, FreeCAD, COMSOL, Code_Aster	4-5	7
DiMAT Materials Modeler	Di^MM	O5	CERTH	i4Q Rapid Quality Diagnosis, ZDMP Prediction and Optimization Designer, i4Q Data-driven Continuous Process Qualification, i4Q Digital Twin Simulation Services, ZDMP Application Builder, ZDMP Product Quality Supervision, Scikit-learn, Tensorflow, Keras, PyTorch, Texgen, Calculix, Digimat, Abaqus,	4-6	7
DiMAT Materials Designer	Di^MD	O5	CETMA	Digimat, FreeCAD, Blender, COMSOL, Code_Aster, Calculix, Warp3D, LAMMPS, SfePy, PolyFem, ZDMP Application Builder	4-5	7
DiMAT Simulation and Optimisation Suite	Di^SOS	O6	UPV			
DiMAT Materials Mechanical Properties Simulator	Di^MMS	O6	AMS	i4Q Rapid Quality Diagnosis, ZDMP Application Builder, ZDMP Prediction and Optimization Designer, ZDMP AI-Analytics run-time, ZDMP Product Quality Supervision, Digimat, Calculix, OpenFoam, MSC-Marc, Abaqus	4-5	7
DiMAT Materials Processing Simulator	Di^MPS	O6	UPV	i4Q Data-driven Continuous Process Qualification, ZDMP Application Builder, ZDMP Prediction and Optimization Designer, ZDMP AI-Analytics run-time, ZDMP Product Quality Supervision, OpenFoam, Moldex3D, Abaqus	4-6	7

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DiMAT Digital Twin for Process Control	Di^{DTPC}	O6	NTUA	i4Q Digital Twin Simulation Services, ZDMP Digital Twin, ZDMP Application Builder, Eclipse Ditto	4-5	7

Table 2: Maturity of DiMAT results.

5.2 DIMAT STANDARDS

Standardisation is a crucial tool for promoting the widespread dissemination and application of the developed solutions in the industry. By promoting the use of agreed upon terminologies, methodologies and construction methods, standardisation helps to lower trade barriers and make project results more accessible beyond the project. Task 8.4 Standardisation is designed to ensure that the DiMAT project is compliant with existing standards and actively contributes to standardisation efforts.

In the first step, comprehensive standards research will be conducted to identify all relevant national, European and international standards and committees. The results of this research will then be evaluated by consortium members and incorporated into the implementation of project activities. To actively contribute to standardisation, the DiMAT project will participate in ISO and CEN working groups and, if appropriate, contribute to the standardisation process.

To further drive the digitalisation of the European industry, DiMAT will contribute to the use case-based application and extension of the MODA and CHADA methodologies to standardise Characterisation and Modelling workflows. The project will ontologize the frameworks using NanoMECommons for CHADA and OpenModel for MODA and contribute to their enrichment and extensions to allow for interoperability between experiment, modelling, simulation and process data.

DiMAT will take into consideration existing relevant standards and ontologies such as MODA, CHADA and EMMO to ensure coherence and align the project's developments with them early on. This will be crucial for driving widespread adoption of the DiMAT Toolkits. All R&D and TECH partners will be actively involved in this undertaking and USER partners will furnish standardisation requirements for the materials value chain. To achieve these goals, it will be necessary for all DiMAT partners to support this task, regardless of whether they have specific person-months allocated to it.

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6 DELIVERABLES AND MILESTONES

As stated in the Grant Agreement, each work package includes specific milestones, and each task has deliverables, which serve as the project's official outputs.

M#	MILESTONE NAME	RELATED WP(S)	DUE DATE (MONTH)	MEANS OF VERIFICATION
M1	Project planning and management structure set-up	1	1	Project Planning defined / Project Management Structure set-up / Project monitoring, control, quality and communication Handbook available
M2	Project Vision Consensus established	2	3	Project Vision Guide Document signed by all partners
M3	Project Dissemination Strategy implemented	8	3	Project Dissemination Strategy defined / DiMAT website set-up and running / Initial release of the public part of the dissemination materials available
M4	Architectural and methodological foundations for the framework delivered	2	9	Detailed Specification of the DiMAT technical architecture / Framework of the Project Released
M5	Requirements identified and assessed	2	12	List of Requirements with average assessment from all partners valorisation published in the DiMAT Project website
M6	Freedom to operate of the KERs confirmed	8	12	Analysis report that confirms the FTO
M7	Exploitation strategy plan developed	8	12	Exploitation strategy available for all partners at the Project Intranet
M8	Periodic progress reports and cost statements released	1	18, 36	Periodic Progress Reports including Financial Statements submitted and approved by EC

M9	Standardisation needs identified	8	12	Minutes of standardisation workshop and list of proposed standardisation needs
M10	DiMAT Toolkits 1st Release	4, 5, 6	18	Software R1 ready for installation and use by Pilots
M11	DiMAT Toolkits 2nd Release	4, 5, 6	24	Software R2 ready for installation and use by Pilots
M12	DiMAT Toolkits addressed to each Pilots tested in factory equipment	7	24	Video report of the DiMAT Toolkits being tested in factory equipment
M13	DiMAT Toolkits Intermediate Releases	4, 5, 6	30, 36	Software intermediate releases ready for installation and use by Pilots.
M14	DiMAT Toolkits addressed to each Pilots validated in test production	7	30	Video report of the DiMAT Toolkits being used in test production
M15	DiMAT Toolkits addressed to each Pilots running in production	7	36	Video report of the DiMAT Toolkits running in real production

Table 3: List of milestones.

The DiMAT project's deliverables (D) are listed in the table below (Table 4).

Del. no.	Deliverable name	WP no.	Lead partici-pant	Type	Due Date	
D1.1	Project Handbook	WP1	CERTH	SEN	M3	31 Mar 2023
D2.1	DiMAT Project Vision	WP2	CERTH	PU	M3	31 Mar 2023
D3.1	DiMAT Architecture	WP3	Fraunhofer	PU	M3	31 Mar 2023
D1.2	Data Management Plan	WP1	CERTH	SEN	M4	30 Apr 2023
D2.2	Benchmarking of Digital Technologies for Materials Modelling, Design, Processing	WP2	NTUA	R	M5	31 May

	and Manufacturing					2023
D8.1	Target-Driven Dissemination Strategy and Plan	WP8	F6S	PU	M6	30 Jun 2023
D3.2	DiMAT Architecture v2	WP3	Fraunhofer	PU	M9	30 Sep 2023
D3.3	DiMAT Viewpoints	WP3	UPV	PU	M9	30 Sep 2023
D2.3	Use cases Scenarios Requirements & KPIs	WP2	DRAXIS	SEN	M12	31 Dec 2023
D8.8	Standardisation	WP8	DIN	PU	M12	31 Dec 2023
D3.4	DiMAT Viewpoints v2	WP3	UPV	PU	M18	30 Jun 2024
D4.1	DiMAT Data and Assessment Suite	WP4	Fraunhofer	PU	M18	30 Jun 2024
D5.1	DiMAT Modelling and Design Suite	WP5	CETMA	PU	M18	30 Jun 2024
D6.1	DiMAT Simulation and Optimisation Suite	WP6	UPV	PU	M18	30 Jun 2024
D8.2	Target-Driven Dissemination Strategy and Plan v2	WP8	F6S	PU	M18	30 Jun 2024
D8.4	Dissemination Materials, Website, Social Networks and Dissemination Activities	WP8	F6S	R	M18	30 Jun 2024
D8.6	Exploitation and Market Readiness	WP8	F6S	PU	M18	30 Jun 2024
D1.3	Data Management Plan v2	WP1	CERTH	SEN	M24	31 Dec 2024
D4.2	DiMAT Data and Assessment Suite v2	WP4	Fraunhofer	PU	M27	31 Mar 2025
D5.2	DiMAT Modelling and Design Suite v2	WP5	CETMA	PU	M27	31 Mar 2025
D6.2	DiMAT Simulation and Optimisation Suite v2	WP6	UPV	PU	M27	31 Mar 2025

D7.1	Piloting and Demonstrating	WP7	AITEX	SEN	M27	31 Mar 2025
D7.3	Impact Assessment and KPI Validation of DiMAT Toolkits	WP7	DRAXIS	SEN	M30	30 Jun 2025
D7.5	Roadmap, Replicability and Lessons Learned	WP7	UPV	PU	M30	30 Jun 2025
D4.3	DiMAT Data and Assessment Suite v3	WP4	Fraunhofer	PU	M36	31 Dec 2025
D5.3	DiMAT Modelling and Design Suite v3	WP5	CETMA	PU	M36	31 Dec 2025
D6.3	DiMAT Simulation and Optimisation Suite v3	WP6	UPV	PU	M36	31 Dec 2025
D7.2	Piloting and Demonstrating v2	WP7	AITEX	SEN	M36	31 Dec 2025
D7.4	Impact Assessment and KPI Validation of DiMAT Toolkits v4	WP7	DRAXIS	R	M36	31 Dec 2025
D7.6	Roadmap, Replicability and Lessons Learned v2	WP7	UPV	PU	M36	31 Dec 2025
D8.3	Target-Driven Dissemination Strategy and Plan v3	WP8	F6S	PU	M36	31 Dec 2025
D8.5	Dissemination Materials, Website, Social Networks and Dissemination Activities v2	WP8	F6S	R	M36	31 Dec 2025
D8.7	Exploitation and Market Readiness v2	WP8	F6S	PU	M36	31 Dec 2025
D8.9	Standardisation v2	WP8	DIN	PU	M36	31 Dec 2025

Table 4: List of deliverables' details.

6.1.1 Deliverables Map

A deliverables map is a crucial tool in project management that helps track the progress of project deliverables. The map provides a visual representation of the interdependencies between the deliverables, including how they relate to each other and how they contribute to the overall project objectives. The DiMAT team has created a deliverables map (Figure 10) that clearly illustrates these interdependencies, using various types of arrows to represent the different aspects of the project deliverables.

The green continuous arrow on the map represents how the input of a finished deliverable contributes to another. This arrow highlights the fact that the output of one task is essential for the completion of another. Similarly, the dashed green arrow shows how an ongoing deliverable receives input from another deliverable that is developing at the same time. This arrow signifies that both tasks are being worked on simultaneously, and the output of one is necessary to progress with the other. The blue dashed arrow represents feedback given to another deliverable. This arrow indicates that the output of one task is being used to improve the output of another. The purple arrow shows the connection of a deliverable to its next iteration, signifying that the output of one task is being used to improve the same task in the next iteration. Finally, the bidirectional red arrow represents a mutual interdependency between two deliverables that are developing in parallel, indicating that both tasks require input from each other to proceed, and the output of one task affects the output of the other.

It is worth noting that among the deliverables mentioned above, D1.1 Project Handbook, D2.1 DiMAT Project Vision, D3.1 DiMAT Architecture, D2.1 Data Management Plan, D2.2 Benchmarking of Digital Technologies for Materials Modelling, Design, Processing and Manufacturing, D8.1 Target-Driven Dissemination Strategy and Plan, D8.6 Exploitation and Market Readiness, and D8.8 Standardisation are foundational deliverables. These deliverables represent the first versions in crucial tasks that will lead to the development of the project. They provide essential inputs and guidelines for the rest of the project work, laying the foundation for the project's success.

For example, D1.1 outlines the project's objectives, methodology, roles, and responsibilities of the partners, while D2.1 and D3.1 set out the project's vision and the first version of the architecture of the DiMAT, respectively. D2.1 provides guidelines for handling data, while D2.2 provides a comprehensive analysis of digital technologies for materials modelling, design, processing, and manufacturing. These foundational deliverables play a vital role in setting the direction and scope of the project, providing a solid framework for the rest of the project work to follow.

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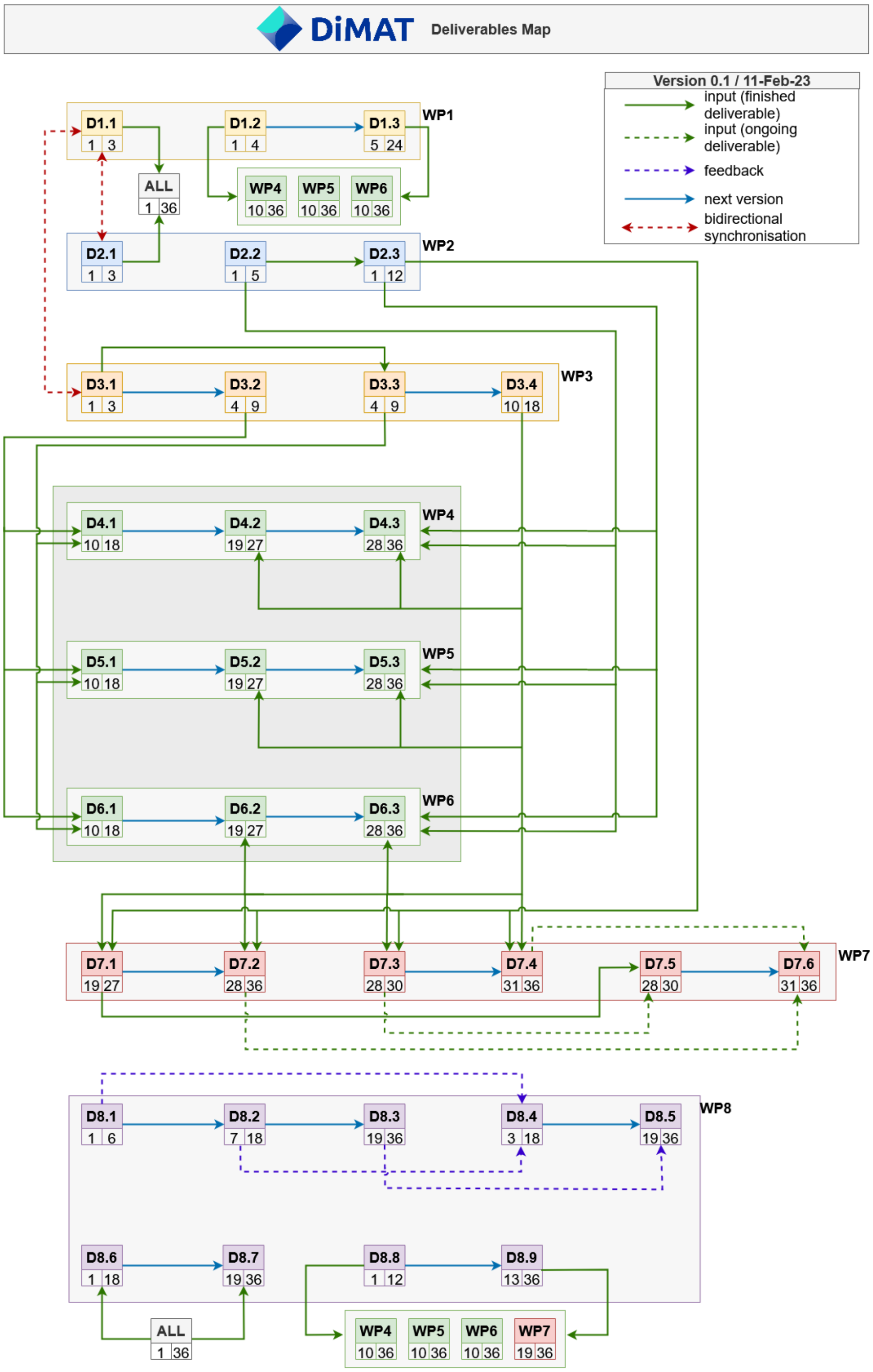

Figure 10: DiMAT Deliverables Map

7 RISKS ASSESSMENT

The critical implementation risks and mitigation actions of DiMAT project are presented below (Table 5):

Description of risk (likelihood/ severity)	WPs invol-ved	Proposed risk - mitigation measures
Failure to meet milestones (Medium/Low)	ALL	Through successful project management, risks and problems are quickly identified and rapid adaptation to changes influencing project planning is accomplished. The Technical Manager (UPV) is in charge of identifying and resolving problems as soon as possible.
Lack of coordination or poor communication (Low/Medium)	ALL	The highly experienced Project Coordinator (CERTH) has significant project management expertise. In addition, all involved partners have participated in projects of equivalent level and standards. The strategic planning regarding project management actions and schemes will ensure proper operational qualification and it will ensure that the project is completed in time and without difficulties.
Under/over estimation effort (High/Medium)	ALL	Special indicators will track closely the ratio of actual required effort versus the planned one, on a regular basis to address this risk. Task Leaders will provide frequent feedback to the Project Coordinator (CERTH) and Technical Manager (UPV) to guarantee feasibility.
Deliverable failure due to missed deadline or poor deliverable quality (Medium/Low)	ALL	Quality management and assurance policies will be implemented in the DiMAT Project. Two project partners will thoroughly review each deliverable. The Task Leader of each task will be in charge of it. The Technical Manager (UPV) will apply the final check for consistency and appropriateness of the deliverables. The Work Package Leaders, the Technical Manager, and the Project Coordinator will seek complementary activities from partners whenever insufficiencies arise. This approach will ensure that each deliverable is in compliance with the project's contractual criteria.
Lack of required know-how (Low/High)	ALL	All the participants in the project have been carefully chosen to meet the project's standards. Their abilities and expertise have been meticulously scrutinised. Their capacity is demonstrated by their effective participation in various EU-funded projects.
Loss of Beneficiary (Medium/Low)	ALL	If the DiMAT consortium includes the terminated activity, the respective funding effort will be assigned to the remaining active partners. If this action is not possible, another organisation with similar standards, specifications, and characteristics will be used.
Loss of required know-how due to departure of key personnel (Medium/Low)	ALL	All the participants are obligated to replace key individuals from the DiMAT Project as soon as possible in case they leave. An effective familiarisation scheme will be set to enable alternative personnel to be quickly integrated in the project. This scheme aims to reduce the amount of time required for training while maintaining excellent standards.
COVID-19 impact on project	ALL	According to the current condition of the pandemic in Europe, the project will organise all meetings while adhering to regulations and travel limitations. To ensure communication within the consortium,

(Medium/Low)		telco conferencing will be available at all times. Meetings and travel will be avoided at all costs, as this could result in COVID-19-related health issues.
Unclear requirements (Low/Medium)	WP2	The definition of the industrial scenarios and the requirement analysis for the materials data and assessment, modelling, design, simulation, and optimisation may result in the formation of unclear use cases scenario requirements. This risk will be mitigated by the use of **SysML** language and the **ISO/IEC/IEEE 29148** standard to document the requirements.
Lack of generality of identified requirements (Low/Medium)	WP2	The pilots are carefully chosen to eliminate this risk. Their respective companies are representative of a variety of European materials industry sectors and cover a wide range of characteristics and requirements.
Weak software design (Low/High)	WP3	The design of the DiMAT Reference Architecture and the viewpoints (Business, Usage, Functional, Implementation) in accordance with the **ISO/IEC/IEEE 42010** standard and the most common reference architectures in the manufacturing domain, such as **IIRA** (primarily), **RAMI4.0, IDSA,** and **IMSA,** is the focus of a full work package (WP3).
Complex technologies for modelling, design and simulation (Medium/High)	WP4, WP5, WP6	A wide range of complex technologies (including AI) will be developed in WP4, WP5 and WP6, aiming to optimise the materials modelling, design and simulation procedures. Due to the involvement of experts in materials modelling (Fraunhofer, UPV, AMS, CETMA) and the strong expertise of all R&D and TECH partners in AI, the risk of failure is critically reduced.
Unavailability of datasets (High/Low)	WP7	Pilots may fail to provide datasets or they may provide datasets irrelevant to the development of the required applications and solutions. This risk is mitigated by an alternative solution where synthetic datasets are generated, being as relevant as possible to the use cases under consideration.
Other similar solutions already present on the market (Medium/Low)	WP2, WP8	The DiMAT Toolkits will adopt state-of-the-art technologies for materials modelling, simulation, and optimisation. They will be effective, practical, user-friendly, and affordable. The consortium members will track closely the market, in order to identify in time any potential new competitors. In order to provide significantly unique solutions in industry the DiMAT Toolkits will be carefully designed and optimised.
Difficulties in exploitation (Low/Medium)	WP8	T8.1 will include the development of a project dissemination strategy, aiming to connect the project with the industrial sector and other stakeholders that may be interested in the project outcomes. This strategy ensures a maximum interaction with various target groups.

Table 5. Critical risks for implementation

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8 CONCLUSIONS

This document will serve as a guide for all project partners, ensuring that tasks remain in sync with the overarching concept of the project. Additionally, the deliverable includes an initial risk table, highlighting the inherent risks of innovation activities in general. The primary objective of this deliverable is to align technology providers' solutions with the pilots' requirements. The vision of the project and the DiMAT Toolkits were clearly explained and described, making it a valuable source for partners in documenting and presenting the project to third parties.

Overall, the DiMAT project is designed to enhance the quality, sustainability, effectiveness and competitiveness of materials by developing open digital tools with advanced technologies for modelling, simulation and optimization at every stage of the material value chain (design, processing and manufacturing) with data analysis services and visualization techniques.

DiMAT will deliver three integrated suites, including the DiMAT Data and Assessment Suite for materials data storage, sharing, representation and assessment; the DiMAT Modelling and Design Suite for material design, in terms of structure, properties and performance; and the DiMAT Simulation and Optimization Suite for efficient material manufacturing simulation and material mechanical characterization

The effectiveness of DiMAT tools will be demonstrated through four industry pilots in the fields of textiles, composites, glass and graphite.

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