DiMAT

STANDARDIZATION

29/12/2023

DiMAT

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

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D8.8 STANDARDIZATION

Report on conducted standardization activities

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Abstract	This deliverable addresses the standardization landscape of DiMAT, and the activities already carried out to analyze the gaps and needs in standardization in this area in order to prepare the standardization strategy for this project.
Keywords	standardization, standards, CWA, MODA, CHADA, EMMO, ISO, CEN, DIN

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EXECUTIVE SUMMARY

The present deliverable D8.8 provides an overview of the first results of Task 8.4 – Standardization, which goes on for the entire duration of the project. This document provides a general summary of the basic knowledge on standardization in order to bring the consortium on a uniform level in this respect. Nevertheless, the focus of this deliverable is on the standardization landscape, which is relevant to the DiMAT project and therefore also other related initiatives.

In a first step, the methodology of the standards research conducted is described. With essential keywords provided by the consortium and pre-defined areas, a search for standards with a strong link to DiMAT was conducted. Mainly international and European standards were included in the standards overview and shared with the project partners in form of a dashboard, developed for DiMAT's standardization landscape analysis. Besides providing a summary on relevant aspects regarding project related standards, the dashboard allows the consortium members to search for specific standards by using keywords. Altogether 366 standards were included in this overview.

The dashboard was also used within this deliverable to provide an overview of the standardization landscape related to DiMAT. The different technical committees on international and European level which are responsible for the development of the standards are described. For particularly relevant topic areas related to DiMAT, possible relevant standards and Technical Committees (TC) on European and international level are described.

All this information about standardization, standards, and TCs related to DiMAT is supposed to raise awareness within the DiMAT consortium of the opportunities that standardization can provide for research and innovation (R&I) projects. This is the essential basis to develop a standardization strategy for DiMAT and to later implement corresponding standardization activities.

In addition to the development of the DiMAT standardization landscape and strategy, a series of workshops were initiated. First, a workshop was held to generate and collect general ideas for standardization, followed by more specific workshops on the CWAs MODA, CHADA and the ontology EMMO. The purpose of these workshops is to elaborate the needs and feasibility of standardization activities within the project lifetime.

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ABBREVIATIONS

AFNOR	French Standardization Association
ANSI	American National Standards Institute
ASD-STAN	Aerospace and defence industries association of Europe - standardization
BSI	British Standards Institution, Federal Office for Information Security
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CWA	CEN Workshop Agreement
DIN	German Institute for Standardization
DKE	German Commission for Electrotechnical, Electronic, and Information Technologies of DIN and VDE
EFTA	European Free Trade Association
EN	European standard
ETSI	European Telecommunications Standards Institute
EU	European Union
ICS	International Classification for Standards
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
IoT	Internet of things
ITU	International Telecommunication Union
IWA	International Workshop Agreement
JTC	Joint Technical Committee
LCA	Life cycle assessment
M2M	Machine-to-machine
NSB	National Standardization Body
R&I	Research and Innovation

SC	Sub committee
SME	Small and medium-sized enterprises
TC	Technical Committee
TR	Technical Report
TS	Technical Specification
UNE	Spanish Association for Standardization
WP	Work Package

1 INTRODUCTION

Standardization[1] is of great importance both at national and European level. On the one hand, international and European standards act as a common language that trading partners use on the global market. This promotes international trade and reduces costs in all areas of the economy. On the other hand, standardization promotes innovation by helping to establish it on the market in the long term. In this way, SMEs and even research projects like DiMAT also take part in shaping the markets of the future. It can be crucial for market success to incorporate aspects of an innovation into standardization in order to prepare the market for it. For example, the creation of European standards can make it easier to export new products and ensure compatibility with existing systems [1]. Although European standardization activities are in the foreground of the EU-funded research project DiMAT, international standardization is also presented, as a transnational harmonization of standardization documents is considered highly relevant and is the basis for the common economic area in the European Union.

DiMAT is about Digital Technologies for modelling, simulation and optimization in each stage of the material value chain (design, processing and manufacturing) with data analysis services and visualization techniques for improving quality, sustainability, effectiveness, and competitiveness of materials. Thus, it is essential to ensure the applicability, trust, and conformity of DiMAT. Therefore, it is a necessity that DiMAT's solutions are compliant with standards, Technical Specifications (TS), and procedures. This is a crucial aspect to guarantee that the developed system is working properly, and the project results are trustworthy. For this reason, DiMAT has integrated standardization as an essential element of the project. Regarding the work structure of DiMAT, standardization is integrated in one work package (WP), namely WP8, in task T8.4.

One objective of T8.4 is to create a well-grounded overview of the current standards and standardization documents as well as relevant technical committees on national, European, and international level related to DiMAT. This will provide an overview of the state of the art of the standardization landscape that is relevant for DiMAT and thus ensure the compliance of the project's results with what is already on the market. The knowledge about existing standards is of importance for the DiMAT consortium to align its products, processes, services and solutions with the current state of the art. The identification of relevant technical

[1] Standardization covers all types of standardization documents and is used here in general manner.

committees is the basis for the direct transfer of DiMAT results into ongoing standardization activities.

The present deliverable D8.8, belonging to T8.4, delivers an overview of the standardization landscape. Besides the necessity to know about ongoing standardization activities, this knowledge also provides the opportunity to raise awareness for standardization needs in this area. Therefore, this deliverable supports the activities in WP 8.

In general, this standardization overview serves as the basis for further standardization activities in DiMAT. Knowing about existing standardization documents makes it possible to build on existing knowledge and avoid unnecessary duplication of work. Additionally, existing gaps in standardization can be better identified and impulses for new standardization activities can be developed.

In contrast to patents, knowledge about standardization is less pronounced, especially in the area of research and innovation. For this reason, the basic principles of standardization are presented in this report (see section 2) as well as the different facets of standardization at international (subsection 2.1.3), European (subsection 2.1.2), and national level (subsection 2.1.1). Subsequently, the various types of standardization documents (subsection 2.2), and the function of standardization in the context of research projects (subsection 2.3) are presented in more detail. The results of the standardization research for DiMAT are presented by explaining the approach to the standards research and finally by giving an overview of the related standardization landscape (section 3). Besides a general overview of the standardization landscape of DiMAT, the relevant international (subsection 3.1) and European (subsection 3.2) are examined. Finally, the initiated workshop series is explained in detail (section 4) and an outlook (section 5) and a summary (section 6) are given.

2 BASICS OF STANDARDIZATION

In general, a standard is a consensus-based document that is approved by a recognized body or organization, reflecting the state of the art. It should be based on the consolidated results of science, technology, and experience, and aim to promote optimal community benefits [2].

Standardization is used to agree on terminologies, methodologies, requirements, characteristics, etc. in specific areas to make a product, process, or service fit for its purpose. Thus, standardization can drive innovative outcomes by agreeing on common product requirements such as interoperability, quality or safety, and provide guidelines for achieving them. Standardization supports the development of a generic language, which is understandable for everyone and thus helps to create a common basis. The result of the standardization process is a document, which provides rules, guidelines or characteristics for activities or their results.

2.1 STANDARD DEVELOPING ORGANIZATIONS

An essential aspect of standardization is to ensure that standardization documents do not contradict each other, especially since European and international standardization have gained significant importance. This is reflected in DIN's statistics, which show that European and international standards account for 90% of all standardization projects nowadays. The following sections give a brief description of the framework of formal standardization on international, European, and national level. Figure 1 provides a general overview of the different types and levels of standardization.

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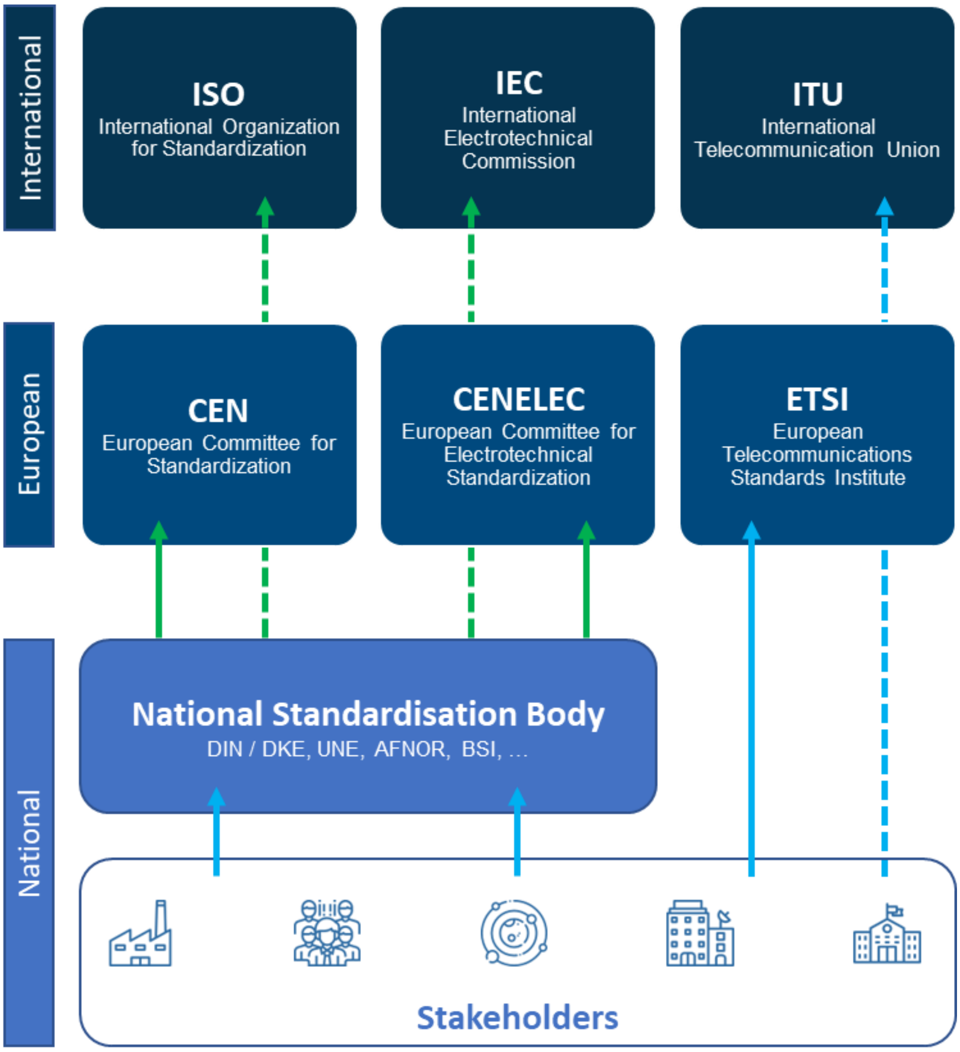

Figure 1: Organizational structure of standardization worldwide after [3]

2.1.1 National standardization

On a national level, there are different structures and standardization bodies in different countries, as e. g. German Institute for Standardization (DIN), German Commission for Electrotechnical, Electronic, and Information Technologies (DKE), Spanish standardization body (UNE), the French Standardization Association (AFNOR) and the British Standards Institute (BSI). In general, each country has one or more recognized national standardization bodies (NSB). Within the NSBs experts from different stakeholders, e.g., from organizations belonging to industry, commerce, the public sector, or research, are developing national standards. These NSBs are also responsible for keeping the national standardization repository updated.

To represent national positions at European or international level, so-called mirror-committees are set up and coordinated by the NSBs. In these national committees, the work and existing results of corresponding European and international standardization committees are discussed, a national opinion is developed, and the final drafts of standards are agreed upon. When European or international draft standards are published for comment, the mirror committees also vote on whether the standard should be published or not.

Here it is important to mention that experts working on European or international level need to be members of the national mirror committee and must be delegated by these committees.

2.1.2 European standardization [6]

The main goal of European standardization is the development of European standards that are valid and accepted within the EU. These European standards are the basis for the European single market. The European standardization organizations CEN [6] (European Committee for Standardization), CENELEC [7] (European Committee for Electrotechnical Standardization), and ETSI [8] (European Telecommunications Standards Institute) are responsible for the organization of European standardization work. CEN is responsible for all non-electronic activities and CENELEC for electrotechnical standardization activities, while ETSI is responsible for the standardization activities in the field of telecommunication at European level.

There is a particularly close cooperation between CEN and CENELEC, which are made up of national standardization organizations from the EU and EFTA (European Free Trade Association) member states, as well as states seeking membership. In contrast, the members of ETSI are directly European companies, institutes, and organizations.

The so-called delegation principle applies to CEN and CENELEC. This means that the mirror committees of the national standardization bodies of their member states send national experts to the technical committees and workings groups at CEN or CENELEC to develop European standards. The European standard (EN) will only be published when a sufficiently large majority of the national standardization organizations has approved the final draft.

European standards (EN) must automatically be adopted by member states of the EU and opposing national standards must be withdrawn. As a result of this mandatory adoption, the EN standards in Germany then become DIN EN standards (e.g., DIN EN 16575). There are situations in which it is possible to complement EN standards with additional national standards, for instance to set more detailed requirements to meet specific needs of the member state.

European specifications are referred to as CWA as well as CEN TS or CENELEC TS, depending on the type of development and their adoption by the member states is voluntary (e.g., DIN CEN/TS 17045), unlike the adoption of European Standards.

2.1.3 International standardization [9]

The international standardization organization ISO (International Organization for Standardization), IEC (International Electrotechnical Commission), and ITU (International Telecommunication Union) are responsible for the organization of international standardization work. ISO is responsible for all non-electronic and IEC for electrotechnical standardization activities, while the ITU is in charge of standardization activities in the field of telecommunications.

ISO and IEC are made up of the national standardization organizations, with e.g., DIN and DKE representing German interests on an international level. The ITU, on the other hand, is a special unit of the United Nations, whose 191 member states develop recommendations together with companies from the private sector and other regional and national organizations. Only when they are adopted by normative organizations such as ISO, American National Standards Institute (ANSI) or ETSI as well as by national regulatory authorities, such as the Federal Network Agency in Germany, they acquire the character of standards.

The so-called delegation principle also applies to ISO and IEC, meaning that the national standardization organizations send their experts to the working groups and technical committees of the international standardization bodies. An international standard (ISO) is only accepted when a sufficiently large majority of the national standardization organizations has voted for its draft. International specifications are called IWA as well as ISO TS or IEC TS, depending on the type of development.

In contrast to European standardization, there is no obligation to adopt international standards in national standards. However, since internationally applicable standards are relevant for international trade or for global stakeholders, conflicting national or European standards should be avoided. There is the possibility of transferring international standards in European and national standards. The resulting documents have the characteristics and names listed in Table 1, depending on the background. There are also parallel processes for developing standards at international and European level. It is possible to directly develop

EN ISO or EN IEC standards without first developing the standard on international level and then adopting it at European level.

NAME	DESCRIPTION
ISO XXXXX	INTERNATIONAL STANDARD ADOPTED ON NEITHER NATIONAL NOR EUROPEAN LEVEL
DIN ISO XXXXX	INTERNATIONAL STANDARD ADOPTED ONLY ON NATIONAL (GERMANY) LEVEL
DIN EN ISO XXXXX	INTERNATIONAL STANDARD ADOPTED ON EUROPEAN AND NATIONAL LEVEL

Table 1: Names of international standards depending on their adoption level

2.2 STANDARDIZATION DOCUMENTS

There are several types of standardization documents that differ in their development process, the degree of consensus to be reached, and the openness to participation (Figure 2). Standardization documents describe products, systems or services by defining their characteristics and requirements and in many cases are publicly available.

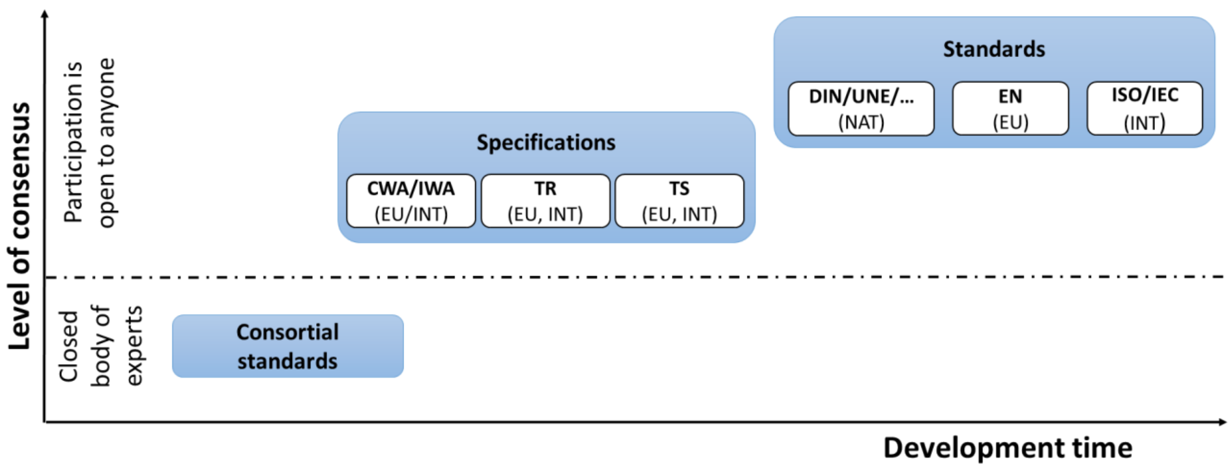

Figure 2: Types of standardization documents after [1]

2.2.1 Standard

According to Figure 2, **standards** in the narrower sense are developed within the formal standardization system where all interested parties have to be included in the development process of the document and consensus, meaning the general agreement of all participants and the lack of sustained objection to central content must be reached. The main objective of the consensus is to take into account the views of all interested parties concerned and to dispel any counter-arguments. The development of a European standard is shown in Figure 3.

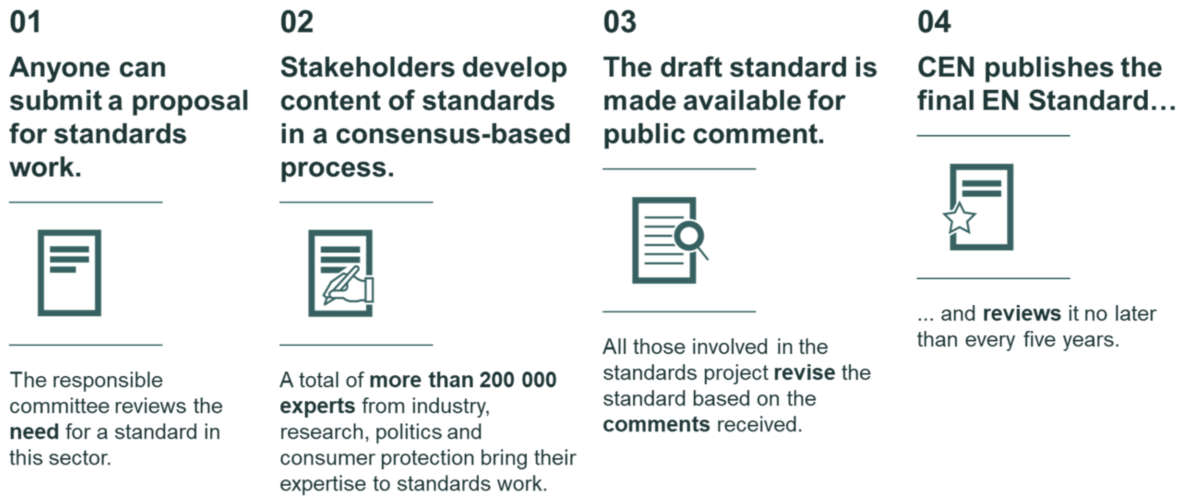

Figure 3: Development of a standard after [1]

First of all, anyone who has identified a need for a standard can submit a proposal for a new standard. In most cases this has to be done via the national mirror committee. The associated standards committee evaluates the need and whether standardization activities are already taking place or if standards that cover the described need exist. If the need is confirmed, a standard is then developed in a standardization committee. Attention is paid to a balanced composition of these committees with all interested parties concerned (science, consumers, industry, etc.) in order to guarantee the neutrality of the documents. A final draft, approved by the standards committee, is then released for public comment. All comments have to be discussed before the final standard is approved by the standardization committee. Due to the high level of transparency and the involvement of the public, the development time increases from national to European and international level. National standards usually require 18 months to develop, while the development of European and international standards normally takes more than two years due to the involvement of the national standardization bodies [9]. Due to the high degree of consensus, standards have a high level of acceptance in society.

2.2.2 Specification

To better understand the difference between the various standardization documents, the terms specification and standard are used. However, in many cases both documents will be called standards. In contrast to a standard created in consensus, the standardization activities in research projects focus mainly on the development of **specifications**. Compared to a standard, consensus is not mandatory in specifications and the involvement of all interested parties is not obligatory. The development of a specification, e.g., CWA on European level, is shown in Figure 4.

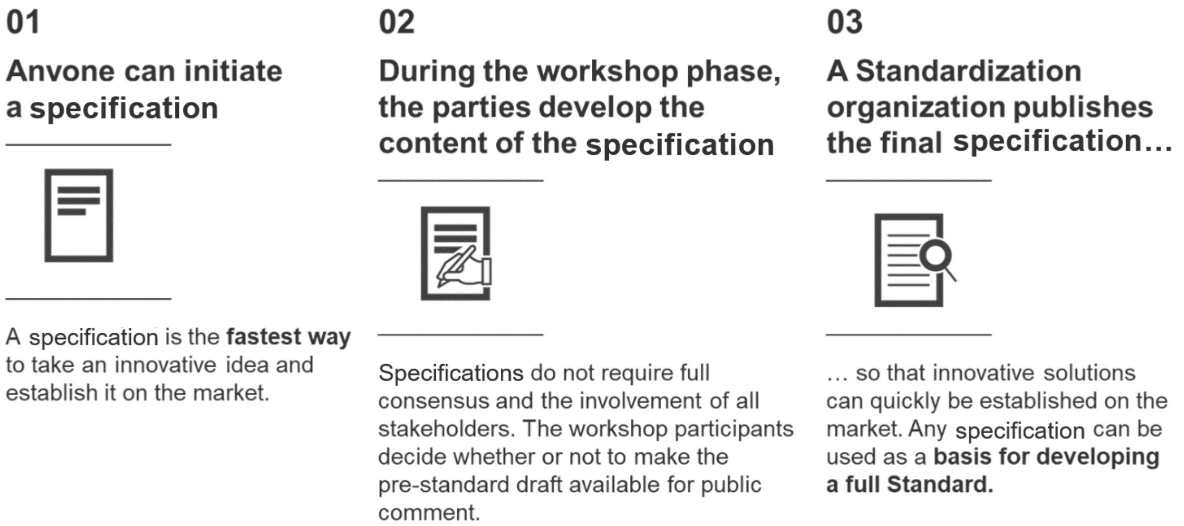

Figure 4: Development of a specification after [10]

Anyone can submit an application to develop a specification. The scope of the specification will be compared with the existing standardization repository. If no conflicting standards exist, the standardization organization publishes the business plan for public comment and a call for cooperation from interested organizations. In contrast to standards, specifications are created in workshops (temporary committee). A standardization organisation acts as a secretary to ensure the procedual requirements and to support the members of the workshops in developing the specification. The workshop also decides whether a draft should be published for comment and once a specification has been successfully adopted by the workshop, the specificaiton will be published.

There are different types of specifications. A Workshop Agreement on European (CEN/CENELEC Workshop Agreement, CWA) or international (International Workshop Agreement, IWA) level is developed in a temporary workshop, which is designed to meet an immediate need and forms the basis for future standardization activities lead by a national standardization body. Even if there are not as strict rules for developing a specification as there are for standards, it is important to ensure the coherence of the standardization regulations to protect the credibility of international, European, and national standardization. The workshop is open to direct participation by anyone who is interested in the development of the agreement but consensus is not required. The development of a Workshop Agreement is fast and flexible, on average between 10 and 12 months and therefore also attractive for research projects. Temporary workshops also develop national specifications, such as DIN SPECs (e.g., DIN SPEC 91392) in Germany.

Specifications can also be developed within standards committees if, for example , no final consensus can be reached. These documents are then referred to as CEN or ISO TS. A TS on European level may not conflict with a European standard but conflicting national standards may continue to exist. Technical Reports (TR) are de-facto documents that are developed and approved by a technical committee. A TR provides information on technical content and standardization work.

2.2.3 Consortial standards

Regarding the development time, the fastest ones are **consortial standards** (see Figure 2), also called industry, informal or de-facto standards. Among other things, they are characterised by the fact that not all interested parties need to be included in the development process. These closed group of experts can be, e. g. industry-specific consortia that have been formed from different companies. Although these documents have some characteristics of a standardization document, such as defined procedures or documentation rules, consortial standards are often not freely accessible and are developed in private.

2.3 STANDARDIZATION IN RESEARCH PROJECTS

It is crucial for an R&I project to know the state of the art in the areas relevant for or connected to the project. Since standards reflect this state of the art in a specific area it is essential for R&I projects to have an overview of the standardization landscape related to the project. This knowledge enables the project to tailor its results or findings to current market requirements and helps ensure that they are interoperable with existing solutions.

R&I projects need to consider the developments within other relevant activities. Irrespective of the technical merits of the R&I project developments, these efforts will be inconsequential if developed in isolation and the market decides to follow another path.

Furthermore, the knowledge about related standards also enables the R&I project to overcome additional challenges and go beyond the current state of the art. On the one hand, an overview of the related standardization landscape offers an R&I project the advantages described above. On the other hand, awareness is raised on where standardization is still needed. This opportunity can be used by the R&I project to implement project results in already ongoing standardization activities or by developing new standards from project results.

For DiMAT in particular, aspects of standardization play an important role. The European research framework program Horizon Europe addresses the topic of standardization in a series of calls for proposals.

3 STANDARDIZATION LANDSCAPE

This section describes the standardization landscape relevant for DiMAT. First, there are the standards that are already applied within DiMAT according to the grant agreement. These include in particular ISO 42010 *"Systems and software engineering - Architecture"* for the architecture design and ISO 22400 *"Automation systems and integration - Key performance indicators"*. The ISO standards on life cycle assessment (LCA) principles, guidelines and requirements, such as ISO 14040 and ISO 14044 as well as ISO/IEC/IEEE 29148 *"Systems and software engineering - Life cycle processes - Requirements engineering"* must also be mentioned here.

A standardization landscape for a specific topic provides an overview of the existing standards relevant and related to the defined topics. Such an overview of the standardization landscape for DiMAT should raise awareness among the project partners on what already exists on the market and prevent them from re-inventing the wheel. Further, the standardization landscape provides the basis for further standardization activities of the project. The approach to developing a standardization landscape is shown in Figure 5.

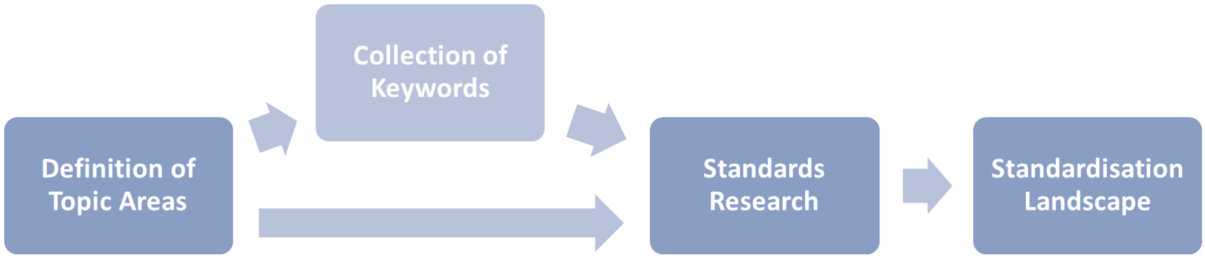

Figure 5: Steps for the development of a standardization landscape

Besides the need to define the topic of advanced digital technologies for each stage of the material value chain, different WPs and tasks refer to it in different approaches. Thus, the first step was to analyze where the project partners needed an overview of existing standards in a specific area of DiMAT.

The basis for providing a standardization landscape for the consortium is the standards research where all the relevant standards for the project are collected. To derive an overview of the current standardization landscape in the area of digital technologies for modelling, simulation and optimization in each stage of the material value chain (design, processing and manufacturing) a survey was conducted within DiMAT. The survey consists of some general questions about the experience in and the general knowledge about standardization as well as current use of standards, previous involvement in standardization activities and already identified gaps in the standardization landscape.

The most important part of the survey is the keywords provided for the standard research. The keywords obtained in the survey served as the basis for research on existing standards and standards under development, as well as identified relevant committees at European and international level. Those keywords were used to search existing standards (standards research) by using the standards database Nautos [11]. The database includes national standards as well as standards from the European organizations CEN, CENELEC, ETSI, and international organizations such as ISO, IEC, and ITU. Regulations, technical documents, and reports on these levels have been considered for the analysis. In case of national standards, it should be noted that due to language barriers mostly those providing at least one English title have been considered.

In the following section an overview of the standardization landscape related to DiMAT is given. Besides providing a general overview of standards which could be relevant for DiMAT, relevant standardization committees that are active in the fields interesting for DiMAT are also given. Using the keywords provided, a total of 366 standards were identified including those mentioned in the survey which are used by the consortium already. The whole list of identified standardization documents is attached in the appendix. These standards represent the first overview of the standardization landscape for DiMAT and were therefore shared with the partners in the form of a dashboard (Figure 6). The dashboard is an Excel tool, which was developed specifically for the research of standards and provides an overview of the main information regarding relevant standards. It can be used to search for specific standards using keywords or to get an overview of the standards within a specific ICS (International Classification for Standards) field or developed by a specific technical committee. This dashboard was shared within the whole DiMAT consortium. Since the development of standards does not stand still, the dashboard will be updated annually.

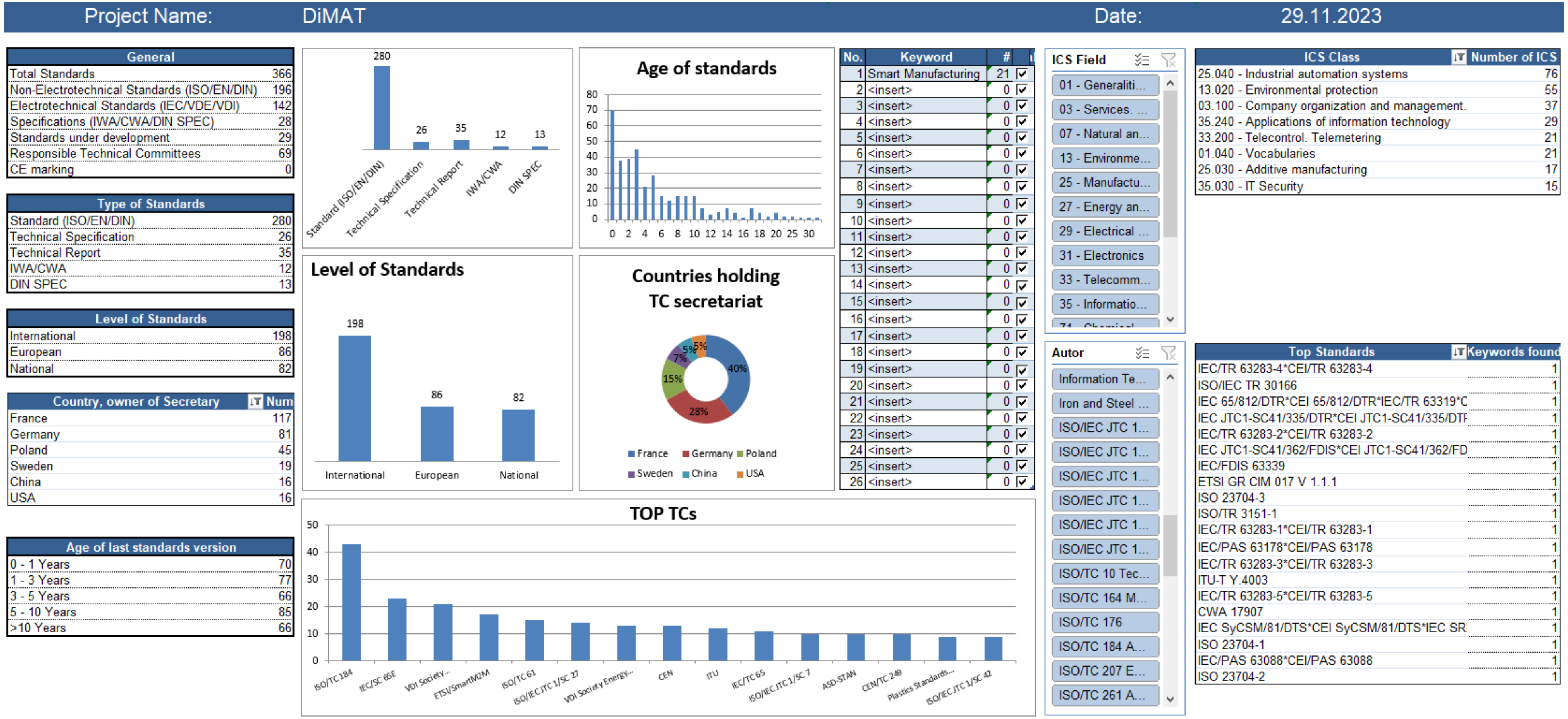

Figure 6: Dashboard with the relevant standards for DiMAT

The dashboard is also used to provide some general information on standards that might be relevant to DiMAT. In Figure 7 the origin of the documents included in the DiMAT dashboard is visualized. The majority (54%) of the standards was developed on international level, whereas around 24% originated on European level and 22% on national level. The reason for the small number of national standards added to the standardization dashboard is because national standards were mostly excluded during the standards research. DiMAT is a European research project and therefore individual national standards are of secondary importance for the first overview of the standardization landscape. National standards will be added to this overview in accordance with the needs of the project partners. Therefore, only standards on international and European level are looked at in the following subsection. In Figure 8 the type of the listed standardization documents is broken down. 77% of the documents included in the dashboard are standards in the narrower sense (see subsection 2.2.1) like ISO- / EN- or national standards whereas the rest are specifications. Nearly 59% of the documents were published or revised within the last 5 years.

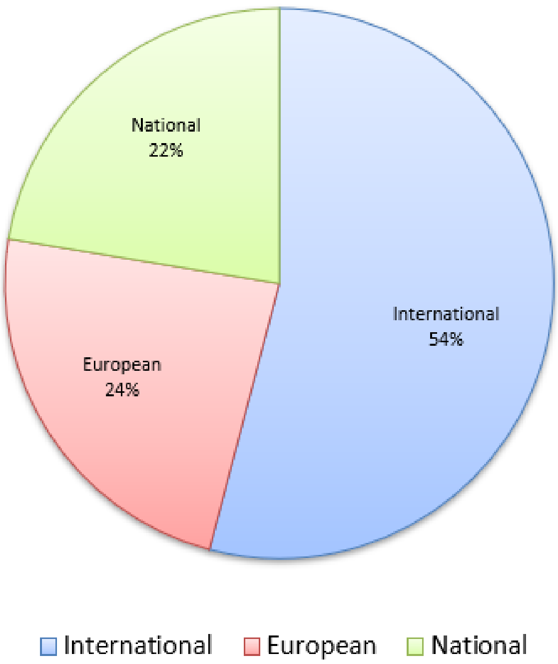

Figure 7: Level of standards

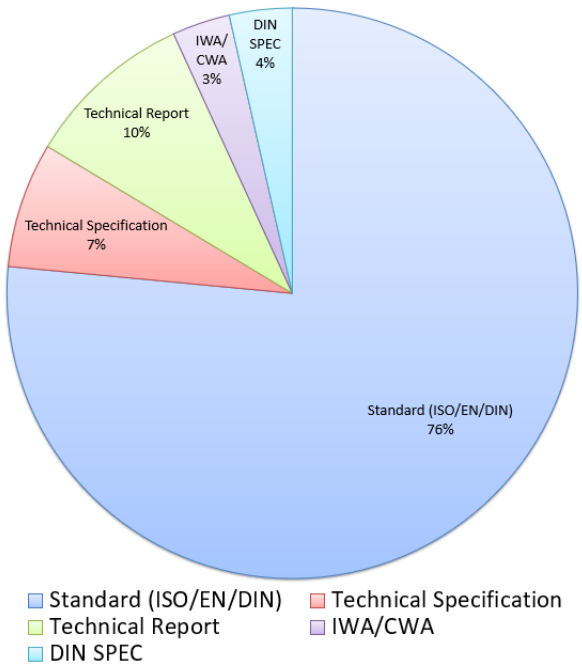

Figure 8: Type of standardization documents

The standards related to the DiMAT cover a wide range of different areas. Based on the ICS (International Classification for Standards) fields, an overview of the different areas can be given (Table 2). The ICS is intended to serve as a structure for catalogues of international, regional, and national standards and other normative documents, as well as a basis for standing-order systems for international, regional and national standards [12]. For this overview only ICS fields which are assigned to at least 15 standards are listed in Table 2. The standards are part of 5 different main ICS fields, whereas "*Manufacturing engineering*", "*Environment, health protection, safety*", and *"Information technology, office machines"* are the most present ones. It is important to keep in mind that one standard can be part of several different ICS fields. 20% of the standards included in the DiMAT dashboard are classified within the sub field 25.040 – "*Industrial automation systems*". Nearly the same amount (15%) of standards is included in 13.020 – "Environmental protection". The third biggest number of standards are part of 03.100 – "*Company organization and management. Management systems*" (10%) and 35.240 – "*Applications of information technology*" (8%).

ICS FIELD		NUMBER OF STANDARDS
MAIN FIELD	SUB FIELD	
25 - MANUFACTURING ENGINEERING	25.040 - INDUSTRIAL AUTOMATION SYSTEMS	76
	25.030 - ADDITIVE MANUFACTURING	17
13 - ENVIRONMENT, HEALTH PROTECTION, SAFETY	13.020 - ENVIRONMENTAL PROTECTION	55
35 - INFORMATION TECHNOLOGY, OFFICE MACHINES	35.240 - APPLICATIONS OF INFORMATION TECHNOLOGY	29
	35.030 - IT SECURITY	15
03 - SERVICES, COMPANY ORGANIZATION, MANAGEMENT AND QUALITY, ADMINISTRATION, TRANSPORT, SOCIOLOGY	03.100 - COMPANY ORGANIZATION AND MANAGEMENT. MANAGEMENT SYSTEMS	37
33 - TELECOMMUNICATIONS, AUDIO AND VIDEO ENGINEERING	33.200 - TELECONTROL. TELEMETERING	21
01 - GENERALITIES, TERMINOLOGY, STANDARDIZATION, DOCUMENTATION	01.040 - VOCABULARIES	21

Table 2: Overview of the number of standards in the different ICS fields

3.1 STANDARDIZATION ACTIVITIES ON INTERNATIONAL LEVEL

From the standards which could be relevant for DiMAT, 199 documents from international level were included in the DiMAT dashboard. The main technical committees, which are responsible for these standards, are listed in Table 3 and are described in the following section. Only TCs that published 9 standards or more of the ones included in the dashboard, are listed and described below.

TC NAME	TC TITLE
ISO/TC 184	AUTOMATION SYSTEMS AND INTEGRATION
IEC/TC 65	INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION
ISO/IEC JTC 1/SC 27	INFORMATION SECURITY, CYBERSECURITY AND PRIVACY PROTECTION
ISO/IEC JTC 1/SC 7	SOFTWARE AND SYSTEMS ENGINEERING
ISO/IEC JTC 1/SC 42	ARTIFICIAL INTELLIGENCE
ISO/TC 61	PLASTICS

Table 3: Relevant standard setting organizations and TCs on international level

The **ISO/TC 184 – Automation systems and integration** focuses on automation systems and their integration for design, sourcing, manufacturing, production and delivery, support, maintenance as well as disposal of products and their associated services. It includes the standardization for information systems, automation and control systems and integration technologies. It has already published 895 ISO standards, whereas 60 are currently under development (including sub committees). Regarding the related international standards for DiMAT, 43 standards in the dashboard were developed by this TC. ISO/TC 184 is composed of 3 sub committees (SC) which are listed in the following [13]:

- SC 1 – Industrial cyber and physical device control
- SC 4 – Industrial data

- SC 5 – Interoperability, integration, and architectures for enterprise systems and automation applications

Due to the overlapping scope of these TCs with the DiMAT project, the tables below list a selection of standards that appear to be relevant and are currently under development in ISO/TC 184 (Table 4), ISO/TC 184/SC 4 (Table 5) and ISO/TC 184/SC 4 (Table 6).

DOCUMENT NO.	TITLE
IEC/CD TR 63319	A META-MODELLING ANALYSIS APPROACH TO SMART MANUFACTURING REFERENCE MODELS
IEC/FDIS 63339	UNIFIED REFERENCE MODEL FOR SMART MANUFACTURING

Table 4: Standards under development from ISO/TC 184 – Automation systems and integration

DOCUMENT NO.	TITLE
ISO/AWI 8000-1	DATA QUALITY — PART 1: OVERVIEW
ISO/PRF 8000-114	DATA QUALITY — PART 114: MASTER DATA: APPLICATION OF ISO/IEC 21778 AND ISO 8000-115 TO PORTABLE DATA
ISO/DIS 8000-118	DATA QUALITY — PART 118: APPLICATION OF ISO 8000-115 TO NATURAL LOCATION IDENTIFIERS
ISO/AWI 8000-200	DATA QUALITY — PART 200: TRANSACTION DATA: QUALITY OF TRANSACTION DATA
ISO/DIS 8000-210	DATA QUALITY — PART 210: SENSOR DATA: DATA QUALITY CHARACTERISTICS
ISO/CD 8000-220	DATA QUALITY — PART 220: SENSOR DATA: QUALITY MEASUREMENT
ISO/AWI TR 8000-320	DATA QUALITY — PART 320: AI TRAINING DATA QUALITY FOR SMART MANUFACTURING
ISO/DPAS 8329	XMCF — DESCRIPTION AND DATA STANDARD FOR CONNECTION AND JOINING DATA IN STRUCTURAL SYSTEMS
ISO/PRF 10303-1	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — PRODUCT DATA REPRESENTATION AND EXCHANGE — PART 1: OVERVIEW AND FUNDAMENTAL PRINCIPLES
ISO/FDIS 10303-2	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — PRODUCT DATA REPRESENTATION AND EXCHANGE — PART 2: VOCABULARY
ISO/DTS 10303-15	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — PRODUCT DATA REPRESENTATION AND EXCHANGE — PART 15: DESCRIPTION METHODS: SYSML XMI TO XSD TRANSFORMATION
ISO/AWI 10303-62	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — PRODUCT DATA REPRESENTATION AND EXCHANGE — PART 62: INTEGRATED GENERIC RESOURCE: EQUIVALENCE VALIDATION OF PRODUCT DATA
ISO/AWI 10303-238	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — PRODUCT DATA REPRESENTATION AND EXCHANGE — PART 238: APPLICATION PROTOCOL: MODEL BASED INTEGRATED MANUFACTURING
ISO/DIS 10303-239	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — PRODUCT DATA REPRESENTATION AND EXCHANGE — PART 239: APPLICATION PROTOCOL: PRODUCT LIFE CYCLE SUPPORT

ISO/AWI 10303-242	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — PRODUCT DATA REPRESENTATION AND EXCHANGE — PART 242: APPLICATION PROTOCOL: MANAGED MODEL-BASED 3D ENGINEERING
ISO/AWI TS 10303-1848	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION - PRODUCT DATA REPRESENTATION AND EXCHANGE — — PART 1848: APPLICATION MODULE: ANNOTATED 3D MODEL DATA QUALITY CRITERIA
ISO/AWI TS 10303-1849	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION - PRODUCT DATA REPRESENTATION AND EXCHANGE — — PART 1849: APPLICATION MODULE: ANNOTATED 3D MODEL DATA QUALITY INSPECTION RESULT
ISO/AWI TS 10303-1855	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — PRODUCT DATA REPRESENTATION AND EXCHANGE — PART 1855: THREADS FOR MECHANICAL PRODUCTS
ISO/DTS 15926-4	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — INTEGRATION OF LIFE-CYCLE DATA FOR PROCESS PLANTS INCLUDING OIL AND GAS PRODUCTION FACILITIES — PART 4: CORE REFERENCE DATA
ISO/CD 15926-6	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — INTEGRATION OF LIFE-CYCLE DATA FOR PROCESS PLANTS INCLUDING OIL AND GAS PRODUCTION FACILITIES — PART 6: METHODOLOGY FOR THE DEVELOPMENT AND VALIDATION OF REFERENCE DATA
ISO/CD TR 17999	REFERENCE MODEL FOR INDUSTRIAL DATA
ISO/CD TS 23164	AUTOMATION SYSTEMS AND INTEGRATION - CORE TERMINOLOGY FOR INDUSTRIAL DATA
ISO/AWI 23247-5	AUTOMATION SYSTEMS AND INTEGRATION — DIGITAL TWIN FRAMEWORK FOR MANUFACTURING — PART 5: PART 5: DIGITAL THREAD FOR DIGITAL TWIN
ISO/AWI 23247-6	AUTOMATION SYSTEMS AND INTEGRATION — DIGITAL TWIN FRAMEWORK FOR MANUFACTURING — PART 6: PART 6: DIGITAL TWIN COMPOSITION
ISO/WD 23726-3	AUTOMATION SYSTEMS AND INTEGRATION — ONTOLOGY BASED INTEROPERABILITY — PART 3: PART 3: INDUSTRIAL DATA ONTOLOGY
ISO/AWI TR 24464	AUTOMATION SYSTEMS AND INTEGRATION — INDUSTRIAL DATA — VISUALIZATION ELEMENTS OF DIGITAL TWINS
ISO/CD 29002	INDUSTRIAL AUTOMATION SYSTEMS AND INTEGRATION — EXCHANGE OF CHARACTERISTIC DATA

Table 5: Standards under development from ISO/TC 184/SC 4 – Industrial data

DOCUMENT NO.	TITLE
ISO/AWI 20850	SUPPLY CHAIN INTEROPERABILITY AND INTEGRATION — PART 210: STRATEGIC SOURCING CONCEPTS, PRINCIPLES, AND DATA REQUIREMENTS
ISO/AWI 21175-1	AUTOMATION SYSTEMS AND INTEGRATION --COLLABORATION ENVIRONMENT REQUIREMENTS OF SIMULATION ON DIFFERENT MANUFACTURING PLATFORMS — PART 1: PART 1: REFERENCE MODEL AND PROCESS

Table 6: Standards under development from ISO/TC 184/SC 5 – Interoperability, integration, and architectures for enterprise systems and automation applications

The scope of **IEC/TC 65 - Industrial-process measurement, control and automation** is to prepare standards for systems and elements used for industrial process measurement, control and automation and to coordinate standardization activities which affect integration of components and functions into such systems including safety and security aspects. This TC already published 49 standards whereas 114 (including SCs) are currently under development [14]. IEC/TC 65 consists of 4 SCs:

- SC 65A – System aspects
- SC 65B – Measurement and control devices
- SC 65C – Industrial networks
- SC 65E – Devices and integration in enterprise systems

Due to the overlapping scope of these TCs with the DiMAT project, the tables below list a selection of standards that appear to be relevant and are currently under development in IEC/TC 65 (Table 7) and IEC/TC 65/SC 65E (Table 8).

DOCUMENT NO.	TITLE
PNW 65-1032 ED1	ASSET ADMINISTRATION SHELL FOR INDUSTRIAL APPLICATIONS – PART 5: INTERFACES
IEC 63278-1 ED1	ASSET ADMINISTRATION SHELL FOR INDUSTRIAL APPLICATIONS – PART 1: ASSET ADMINISTRATION SHELL STRUCTURE
IEC 63278-2 ED1	ASSET ADMINISTRATION SHELL FOR INDUSTRIAL APPLICATIONS – PART 2: INFORMATION META MODEL
IEC 63278-3 ED1	ASSET ADMINISTRATION SHELL FOR INDUSTRIAL APPLICATIONS – PART 3: SECURITY PROVISIONS FOR ASSET ADMINISTRATION SHELLS
IEC 63278-4 ED1	ASSET ADMINISTRATION SHELL FOR INDUSTRIAL APPLICATIONS - PART 4: USE CASES AND MODELLING EXAMPLES
IEC TR 63283-2 ED2	INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION - SMART MANUFACTURING - PART 2: USE CASES
IEC TR 63283-4 ED1	INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION – SMART MANUFACTURING – PART 4: RECOMMENDATIONS FOR THE USAGE OF NEW TECHNOLOGIES
IEC TR 63283-5 ED1	INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION – SMART MANUFACTURING – PART 5: MARKET AND INNOVATION TRENDS ANALYSIS
IEC TR 63319 ED1	A META-MODELLING ANALYSIS APPROACH TO SMART MANUFACTURING REFERENCE MODELS
IEC 63339 ED1	UNIFIED REFERENCE MODEL FOR SMART MANUFACTURING
ISO 20140-5 ED2	AUTOMATION SYSTEMS AND INTEGRATION - EVALUATING ENERGY EFFICIENCY AND OTHER FACTORS OF MANUFACTURING SYSTEMS THAT INFLUENCE THE ENVIRONMENT - PART 5: ENVIRONMENTAL PERFORMANCE EVALUATION DATA

Table 7: Standards under development from IEC/TC 65 – Industrial-process measurement, control and automation

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DOCUMENT NO.	TITLE
IEC 61987-1 ED2	INDUSTRIAL-PROCESS MEASUREMENT AND CONTROL - DATA STRUCTURES AND ELEMENTS IN PROCESS EQUIPMENT CATALOGUES - PART 1: MEASURING EQUIPMENT WITH ANALOGUE AND DIGITAL OUTPUT
IEC 61987-32 ED1	INDUSTRIAL-PROCESS MEASUREMENT AND CONTROL - DATA STRUCTURES AND ELEMENTS IN PROCESS EQUIPMENT CATALOGUES - PART 32: LISTS OF PROPERTIES (LOP) FOR I/O MODULES FOR ELECTRONIC DATA EXCHANGE
IEC 61987-41 ED1	IEC 61987, PART 41: GENERIC STRUCTURES OF LIST OF PROPERTIES (LOP) OF PROCESS ANALYZER TECHNOLOGY (PAT) MEASURING DEVICES FOR ELECTRONIC DATA EXCHANGE
IEC 61987-100 ED1	INDUSTRIAL-PROCESS MEASUREMENT AND CONTROL - DATA STRUCTURES AND ELEMENTS
IEC 62453-1 ED3	FIELD DEVICE TOOL (FDT) INTERFACE SPECIFICATION - PART 1: OVERVIEW AND GUIDANCE
IEC TR 62453-42 ED2	FIELD DEVICE TOOL (FDT) INTERFACE SPECIFICATION - PART 42: OBJECT MODEL INTEGRATION PROFILE - COMMON LANGUAGE INFRASTRUCTURE
IEC 62541-1 ED1	OPC UNIFIED ARCHITECTURE – PART 1: OVERVIEW AND CONCEPTS
IEC 62541-5 ED4	OPC UNIFIED ARCHITECTURE - PART 5: INFORMATION MODEL
IEC 62714-6 ED1	ENGINEERING DATA EXCHANGE FORMAT FOR USE IN INDUSTRIAL AUTOMATION SYSTEMS ENGINEERING - AUTOMATION MARKUP LANGUAGE - PART 6: AUTOMATIONML COMPONENTS
IEC 63489 ED1	DB - COMMON DATA CONCEPTS FOR SMART MANUFACTURING
IEC 63538 ED1	LIFECYCLE-EVENTS: INFORMATION MODELS AND SERVICES

Table 8: Standards under development from IEC/TC 65/SC 65E – Devices and integration in enterprise systems

ISO/IEC JTC 1 - Information technology founded in 1987 is a joint technical committee from ISO and IEC focusing on the development of ICT standards for business and consumer applications. It has already published 3439 ISO/IEC standards, whereas nearly 500 are currently under development. This JTC published 33 standards included in the DiMAT standardization dashboard. ISO/IEC JTC 1 is composed of 23 subcommittees whereas the most relevant ones are described in the following [15]:

- SC 27 – Information security, cybersecurity and privacy protection published 14 of the DiMAT related standards of the dashboard. This SC was created in 1989 and aims to develop standards for the protection of information and ICT. This includes generic methods, techniques and guidelines to address both security and privacy aspects. There are already 240 standards which were published by this SC and 69 are under development [16].

- SC 7 – Software and systems engineering is on international level responsible for standardization of processes, supporting tools and supporting technologies for the engineering of software products and systems. ISO/IEC JTC 1/SC 7 published 214 standards so far and has currently 41 in development [17]. This SC published 10 which were included in the DiMAT standardization dashboard.

- SC 42 – Artificial intelligence was created in 2017 and serves as the focus and proponent for JTC 1's standardization program on Artificial Intelligence. It provides guidance to JTC 1, IEC, and ISO committees developing Artificial Intelligence applications. This SC developed 9 of those standards included in the dashboard and in general already published 20 ISO standards whereas 35 are currently under development [18].

Due to the overlapping scope of these TCs with the DiMAT project, the tables below list a selection of standards that appear to be relevant and are currently under development in ISO/IEC JTC 1/SC 7 (Table 9).

DOCUMENT NO.	TITLE
ISO/IEC/IEEE FDIS 24748-1	SYSTEMS AND SOFTWARE ENGINEERING — LIFE CYCLE MANAGEMENT — PART 1: GUIDELINES FOR LIFE CYCLE MANAGEMENT
ISO/IEC/IEEE FDIS 24748-2	SYSTEMS AND SOFTWARE ENGINEERING — LIFE CYCLE MANAGEMENT — PART 2: GUIDELINES FOR THE APPLICATION OF ISO/IEC/IEEE 15288 (SYSTEM LIFE CYCLE PROCESSES)
ISO/IEC PRF 25002	SYSTEMS AND SOFTWARE ENGINEERING — SYSTEMS AND SOFTWARE QUALITY REQUIREMENTS AND EVALUATION (SQUARE) — QUALITY MODELS OVERVIEW AND USAGE
ISO/IEC DIS 25040	SYSTEMS AND SOFTWARE ENGINEERING – SYSTEMS AND SOFTWARE QUALITY REQUIREMENTS AND EVALUATION (SQUARE) – QUALITY EVALUATION FRAMEWORK
ISO/IEC AWI TS 25052-2	SYSTEMS AND SOFTWARE ENGINEERING — SYSTEMS AND SOFTWARE QUALITY REQUIREMENTS AND EVALUATION (SQUARE): CLOUD SERVICES — PART 2: QUALITY MEASUREMENT
ISO/IEC CD TR 29119-8.2	SOFTWARE AND SYSTEMS ENGINEERING — SOFTWARE TESTING — PART 8: MODEL-BASED TESTING
ISO/IEC CD TR 29119-14	SOFTWARE AND SYSTEMS ENGINEERING — SOFTWARE TESTING — PART 14: DATA MIGRATION TESTING
ISO/IEC DTS 33060	INFORMATION TECHNOLOGY — PROCESS ASSESSMENT — PROCESS ASSESSMENT MODEL FOR SYSTEM LIFE CYCLE PROCESSES

Table 9: Standards under development from ISO/IEC JTC 1/SC 7 – Software and systems engineering

ISO/TC 61 – Plastics deals with nomenclature, methods of test, and specifications applicable to materials and products in the field of plastics including processing (of products) by assembly, but not limited to, polymeric adhesives, sealing, joining, welding. The standardization work within this TC already resulted in 735 documents, whereas 97 are currently being developed [19]. 15 documents published by this TC are contained in the DiMAT standardization dashboard.

3.2 STANDARDIZATION ACTIVITIES ON EUROPEAN LEVEL

On European level, according to the standardization dashboard, 135 documents relevant for DiMAT have been published so far. In Table 10 the main technical committees, which are responsible for these standards are listed and described below. In this section, only those committees responsible for 10 or more documents in the dashboard are considered.

TC/ORGANIZATION	TITLE
CLC/TC 65X	INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION
CEN/TC 310	ADVANCED AUTOMATION TECHNOLOGIES AND THEIR APPLICATIONS
ETSI/SMARTM2M	SMART MACHINE-TO-MACHINE COMMUNICATIONS (SMARTM2M)
CEN	EUROPEAN COMMITTEE FOR STANDARDIZATION (WORKSHOP AGREEMENTS)
ASD-STAN	AEROSPACE AND DEFENCE INDUSTRIES ASSOCIATION OF EUROPE - STANDARDIZATION
CEN/TC 249	PLASTICS

Table 10: Relevant standard setting organizations and TCs on European level

CLC/TC 65X – Industrial-process measurement, control and automation is at European level the counterpart of IEC/TC 65, which is important for DiMAT at international level, and is therefore included here. Its scope is to contribute, support and coordinate the preparation of international standards for systems and elements used for industrial process measurement, control and automation at CENELEC level. 509 standards are already published by CLC/TC 65X, whereas 2 of them are included in the dashboard. And 91 documents ae currently under development [20].

CEN/TC 310 – Advanced automation technologies and their applications is also a counterpart at European level, namely of ISO/TC 184 and is therefore included here. CEN/TC 310 has not developed any standards that are included in the dashboard, but in general has already published 7 standards whereas 3 are currently under development [21].

ETSI/SmartM2M is a TC which mainly develops standards to enable machine-to-machine (M2M) services and applications and certain aspects of the Internet of Things (IoT), and it already published 110 standardization documents (exclusively TR and TS) in this field [22]. ETSI/SmartM2M is responsible for 17 standards contained in the standardization dashboard of DiMAT.

As already described in subsection 2.1, **CEN** is not a TC as such, but is nevertheless listed above in Table 10 because there are 12 CWAs included in the dashboard which were developed in temporary workshops (see subsection 2.2.2) on European level.

As an associated body to CEN, **ASD-STAN** establishes, develops and maintains standards on behalf of European aerospace industry. More than 2500 standards, 301 draft standards, and 68 TRs are already published by ASD-STAN [23]. The standardization dashboard of DiMAT includes 10 of them.

The scope of **CEN/TC 249 – Plastics** covers all standardization activities regarding terminology, test methods, specifications, classifications and designation systems, environmental aspects, joining systems and techniques of plastics, plastic-based materials, semi-finished products and products [24]. CEN/TC 249 already published 510 standards and 74 are currently under development [25].

4 STANDARDIZATION WORKSHOPS

4.1 STANDARDIZATION POTENTIALS WORKSHOP

4.1.1 Purpose and concept

The aim of this workshop is to find potential topics for new standards, which originate from the experience and the daily tasks and challenges of the project partners and further to develop a common and coordinated plan for further standardization activities with the knowledge of all experts involved in the DiMAT project. As the Horizon Calls addresses new and relevant topics in emerging fields, the chance is high that the project partners experience needs for additional standards or adjustment of existing standards in their project work. The general concept of this workshop was successfully used in different horizon projects before i.e., in BIMprove [26] and modified to fit to the needs of DiMAT.

Standards should be utilized as enablers, which lay a common ground on which new advancements in new technologies can be built upon. In some cases, disruptive technologies may miss support in existing standards that leads to a need for the adjustment of those standards. One of the activities to identify these gaps and needs was the standardization potentials workshop whose agenda is shown in Table 11. The workshop took place on September 7th, 2023. A few days before the workshop was held some guiding questions were shared to inspire:

- Is there a methodology/process/result within your DiMAT task you would like to recommend to someone outside the project to work with?
- Are you facing problems communicating your findings? Do your colleagues understand you when you are explaining your work? Could a terminology standard help?
- Do you sometimes discuss the quality of results in your field with your colleagues? Could a standard set minimum requirements?
- Is there anything within DiMAT you need to agree on with other partners, e.g., related to interoperability or compatibility? Could this become a standard outside DiMAT?

After the working phase the experts were asked to present and explain their ideas. In the following all participants had the opportunity to evaluate the ideas generated. Thereby, each person had up to 3 votes to vote for what they considered to be the best ideas.

<table>
<tr><th>PLANNED DURATION</th><th>ITEM DESCRIPTION</th><th>PRESENTER</th></tr>
<tr><td colspan="3">WELCOME AND ROUND OF INTRODUCTION</td></tr>
<tr><td>[15 MIN]</td><td>- What is your name?
- What is your role in the project?</td><td>ALL</td></tr>
<tr><td colspan="3">PRESENTATION</td></tr>
<tr><td>[20 MIN]</td><td>- Short revision: main facts about standardization
- Aim for today</td><td>DIN</td></tr>
<tr><td colspan="3">FAMILIARIZE WITH THE SOFTWARE TOOL “CONCEPTBOARD”</td></tr>
<tr><td>[10 MIN]</td><td>- Short training of the functions used in the workshop
- Including small “Ice Breaker”
o Where are you currently working in Europe? (North/South)
o What is your favourite holiday location? (mountain, beach, city)</td><td>ALL</td></tr>
<tr><td colspan="3">“WARMING UP”: LIVE POLLS</td></tr>
<tr><td>[10 MIN]</td><td>- Questions to learn about the standardization experience and needs of the participants
o How familiar are you with standardization?
o Which benefits of standards are important for DiMAT?
o I can imagine something under these types of standards...
o Today, I brought a standardization idea with me
- Introducing the voting tool which is used in the later ranking session</td><td>ALL</td></tr>
<tr><td colspan="3">IDENTIFICATION OF CHALLENGES - WHAT SHOULD BE STANDARDIZED?</td></tr>
<tr><td>[20 MIN]</td><td>- Guiding questions to inspire the participants were shared</td><td>ALL</td></tr>
</table>

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	- The participants place sticky notes with their ideas on the board - For inspiration, standard types and project topics form a matrix where the notes can be placed	
	BREAK	
[15 MIN]		
	SHORT PRESENTATION OF THE POTENTIALS	
[30 MIN]	- The participants explain each of their standardization needs or ideas - The audience can form an opinion on the importance of the idea - The explanations will be noted in the minutes for further analysis and support	ALL
	EVALUATION AND RANKING	
[15 MIN]	- Each of the participant has three votes to spread among the ideas - Each of the participant can place one or more avatars at the ideas where he/she is interested in or experienced with.	ALL
	SUMMARY AND FEEDBACK	
[10 MIN]	- Short summary of the work done - Possibility to rate the workshop and to place some sticky notes for feedback	ALL
	NEXT STEPS	
[10 MIN]	- The ideas will be analyzed to decide on which ideas to follow further - Further workshops on MODA, CHADA and EMMO will be done	DIN
	END OF MEETING	

Table 11: Agenda of standardization potentials workshop

4.1.2 Results

The workshop was attended by 22 people from various DiMAT partners, and 9 participants never worked with the utilized tool “Concept board” before. 6 participants use standards in their daily business and 2 participants already participated in standardization. The most important benefits for DiMAT are interoperability, market acceptance and quality and one participant brought a standardization idea to the workshop. In the working phase of the workshop 33 ideas were created and briefly presented afterwards. The results are shown on the board in Figure 9 and are also detailed in Table 12, in which only ideas for which 2 or more votes were submitted are listed.

These ideas will be further summarized in categories and analyzed by DIN from a standardization perspective in terms of feasibility and relevance for the project and beyond. In the next steps, these results will be discussed and further elaborated with the idea providers and other interested parties.

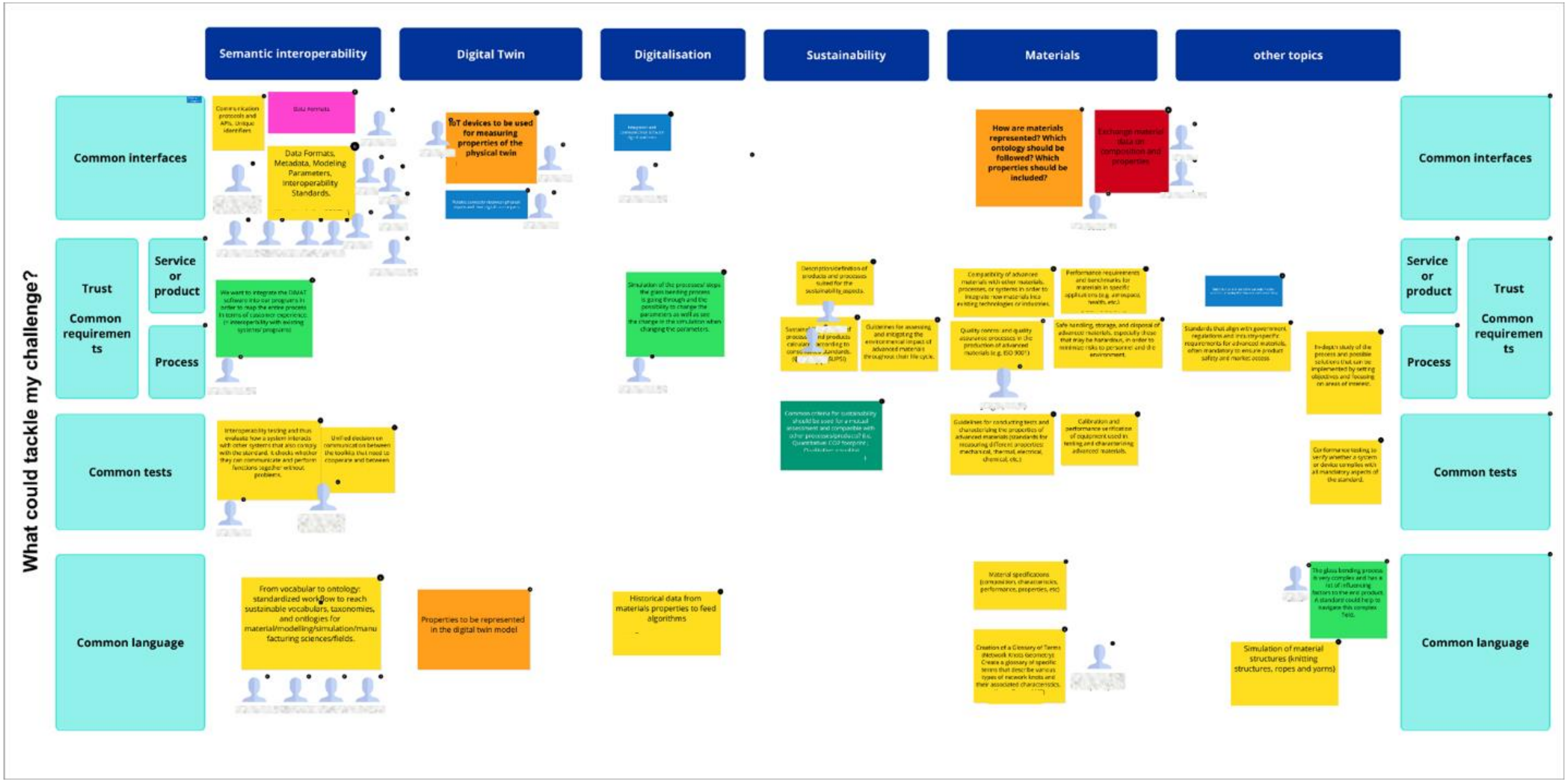

Figure 9: Main results standardization potentials workshop

TOPIC	STANDARD TYPE	TITLE	SCORE
Semantic inter-operabilitiy	Common interfaces	Data formats, metadata, modeling parameters, interoperability standards	8
Semantic inter-operabilitiy	Trust, service or product, terminology	We want to integrate the dimat software into our programs in order to map the entire process in terms of customer experience. (= interoperbility with existing systems/ programs)	3
Semantic inter-operabilitiy	Common tests	Interoperability testing and thus evaluate how a system interacts with other systems that also comply with the standard. It checks whether they can communicate and perform functions together without problems.	5
Semantic inter-operabilitiy	Common language	From vocabular to ontology: standardized workflow to reach sustainable vocabulars, taxonomies, and ontlogies for material/modelling/simulation/manu facturing sciences/fields.	5
Digitalization	Trust common requirements	Simulation of the processes/ steps the glass bending process is going through and the possibility to change the parameters as well as see the change in the simulation when changing the parameters.	3
Digitalization	Common language	Historical data from materials properties to feed algorithms	4
Sustainability	Trust common requirements	Sustainability impacts of processes and products calculated according to consolidated standards.	2
Sustainability	Trust common requirements	Guidelines for assessing and mitigating the environmental impact of advanced materials throughout their life cycle.	3

Materials	Trust common requirements	Compatibility of advanced materials with other materials, processes, or systems in order to integrate new materials into existing technologies or industries.	3
Materials	Common tests	Guidelines for conducting tests and characterizing the properties of advanced materials (standards for measuring different properties: mechanical, thermal, electrical, chemical, etc.)	3
Sustainability	Common tests	Common criteria for sustainability should be used for a mutual assessment and comparible with other processes/products? (i.e. Quantitative: co2 footprint; qualitative: equality)	2
Materials	Common interfaces	How are materials represented? Which ontology should be followed? Which properties should be included?	2
Materials	Common interfaces	Exchange material data on composition and properties	5
Materials	Common language	Material specifications (composition, characteristics, performance, properties, etc)	3
Materials	Common language	Creation of a glossary of terms (network knots geometry): create a glossary of specific terms that describe various types of network knots and their associated characteristics.	2

Table 12: Ideas generated during the workshop

4.2 1ST WORKSHOP ON MODA, CHADA AND EMMO

4.2.1 Purpose and concept

Due to the Horizon Call (HORIZON-CL4-2022-RESILIENCE-01), which states that the project should build on the existing CWAs MODA (document no.: CWA 17284; “materials MOdelling DAta”) and "CHADA" (document no.: CWA 17815; “materials CHAracterization DAta”) as well as the ontology "EMMO" (“Elementary Multiperspective Materials Ontology”), in cooperation with colleagues from Fraunhofer IWM a second standardization workshop was organized on October 10th, 2023. The workshop was prepared and held by Fraunhofer IWM and was moderated by DIN. The initial aim was to familiarize participants with these documents and their content. It also aimed to answer the question of whether and how they could be applied, adapted or possibly expanded for the work in the project.

As the Horizon Call addressed other projects with similar fields of activity, they were contacted in advance and asked whether they would be interested in taking part in the workshop. There was a great interest and as a result, the following projects also took part in the workshop:

- PIONEER – Open Innovation Platform for Optimising Production Systems By Combining Product Development, Virtual Engineering Workflows and Production Data [27]
- metaFacturing – Data and METAdata for advanced digitalization of manuFACTURING industrial lines [28]
- AID4GREENEST – AI powereD characterization and modelling for GREEn STeel technology [29]

They are all part of the same Call as DiMAT and share similar topics with the DiMAT project, especially in the context of the MODA, CHADA, and EMMO standards. This approach makes a lot of sense in terms of interoperability, and it is hoped to create synergies with these projects and involve them in the standardization activities. The projects are referred in the following as "sister projects".

This workshop therefore served to get to know MODA, CHADA and EMMO, as some partners had never heard of them before, but also to get to know the other consortia with similar challenges. In Table 13 the agenda of this meeting is presented.

PLANNED DURATION	ITEM DESCRIPTION	PRESENTER
INTRODUCTION & OVERVIEW		
[20 MIN]	- Welcome - Summary of the results of the standardization potential workshop - Some basic knowledge about standardization - Aim for today	Marcus Letz (DIN), Dirk Helm (Fraunhofer IWM)
INTRODUCTION SISTER PROJECTS		
[15 MIN]	- PIONEER - metaFacturing - AID4GREENEST - DiMAT	Coordinators/representatives
MODA		
[30 MIN]	- Terms and definitions - Classification of materials models - Documentation of simulation - MODA App (developed by Fraunhofer IWM)	Dirk Helm, Yoav Nahshon (Fraunhofer IWM)
BREAK		
[10 MIN]		
CHADA		
[30 MIN]	- General scheme - Examples - iCHADA and NanoMECommons	Dirk Helm, Yoav Nahshon, Kuo-I Chang (FRAUNHOFER IWM)
EMMO		
[30 MIN]	- What is an ontology ? - Comparing ontologies for different perspectives of représentations - EMMO : Elementary Multiperspective Materials Ontology o Features o Perspectives	Matthias Büschelberger (FRAUNHOFER IWM)

	○ CHAMEO - Ontologization of MODA UC from MarketPlace project - Ontologization of CHADA TMA UC	
OPEN DISCUSSION		
[20 MIN]		ALL

Table 13: Agenda of 1st Workshop on MODA, CHADA and EMMO

4.2.2 Results

One of the key findings during the workshop was the realization that further sessions will be necessary to drive the topics forward. A follow-up survey was also conducted, in which 14 people from all sister projects took part. The survey asked for feedback on the workshop content and understanding of MODA, CHADA and EMMO, among other things. It was mentioned several times that the workshop was very interesting and important for most of the partners. The responses also made it clear afterwards that more follow-up activities are needed (see Figure 10) to figure out how the content can be implemented and applied within the projects.

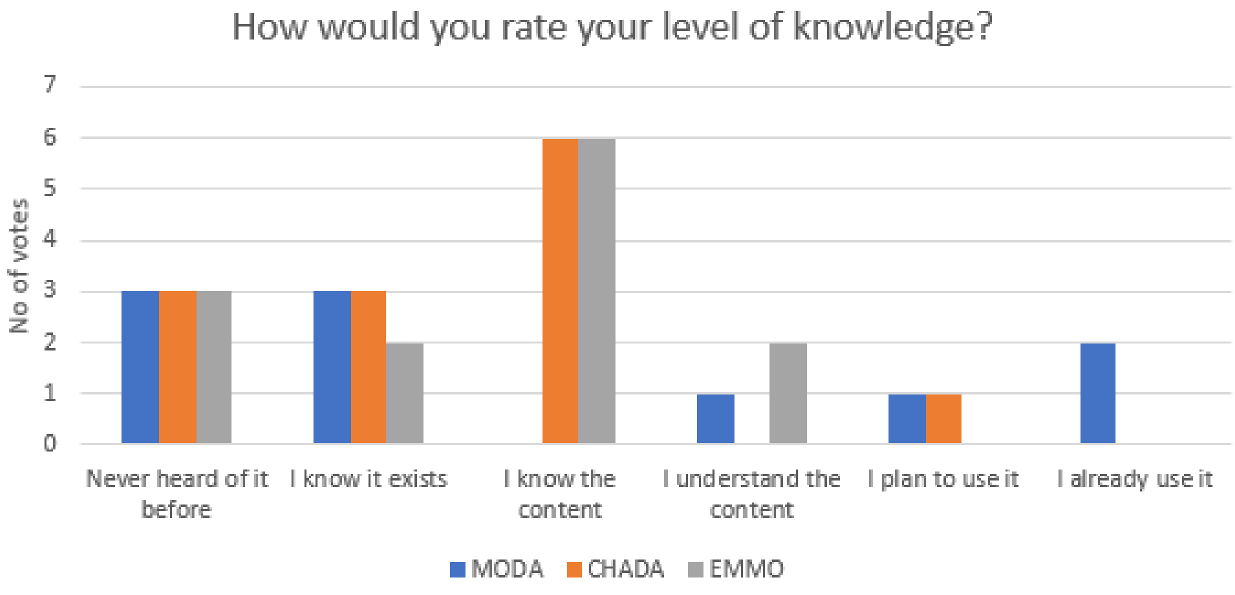

Figure 10: Level of knowledge about MODA, CHADA and EMMO after the 1st workshop

4.3 2ND WORKSHOP ON MODA, CHADA AND EMMO

A further workshop was therefore held on December 7th, 2023 to further improve the knowledge about these concepts across the projects. This workshop was attended by up to 48 participants and continued to pursue the goal of jointly discussing possibilities for implementation and application. In addition, another project was invited to the workshop, namely NanoMECommons [30], which is the follow-up project to OYSTER [31], in which CHADA was conceptualized. One of the main attempts of NanoMECommons is to make CHADA interoperable, which is very beneficial to the aim of the workshop. The main developers of the CHAMEO ontology, which will support the interoperability of CHADA, are part of this project. This also provides an opportunity to learn more details about CHADA and the work involved.

Therefore, the agenda of this meeting (see Table 14) included a slot for a general introduction of the NanoMECommons project and for presenting recent and planned activities. There was also a summary of the last workshop, a presentation of the answers to the follow-up questions and the status of current ideas for the role of MODA and CHADA in DiMAT. After the presentations, there was time for open discussion and brainstorming. It became clear that a further session of a practical nature is required, although this was already clear before this meeting. This is expected to take place in spring 2024.

PLANNED DURATION	ITEM DESCRIPTION	PRESENTER
[5 MIN]	INTRODUCTION & OVERVIEW	DIN
[10 MIN]	RECAP OF LAST SESSION	Fraunhofer IWM
[10 MIN]	EVALUATION OF THE ANSWERS TO FOLLOW-UP QUESTIONS	DIN
[15 MIN]	CONTRIBUTIONS OF NANOMECOMMONS	Representatives of the project
[15 MIN]	STATUS OF IDEAS ON THE ROLE OF MODA AND CHADA IN DIMAT	Fraunhofer IWM
[25 MIN]	BRAINSTORMING	ALL

Table 14: Agenda of 2nd Workshop on MODA, CHADA and EMMO

5 OUTLOOK

The standardization activities in DiMAT have started well. Further steps will be finalized over the next few months.

Standardization ideas

As indicated in section 4.1, the results of the standardization potentials workshop will be discussed and further elaborated with the idea providers and other interested parties. This will be synced with the consideration about possible standardization activities regarding MODA, CHADA and EMMO to ensure that the resources of the DiMAT partners are focused and used in an efficient way. Accordingly, less activities with higher possible capacities will be prioritized over many different activities. It would be a good possibility to hand in a proposal for a new standard or to propose and create another CWA.

MODA, CHADA and EMMO

Further workshops are needed to get a clearer picture of whether and in what form standardization activities are required for MODA, CHADA and EMMO. There will also be meetings with the DIN standardization committees concerned, which are already involved in similar activities. DIN will create a direct link to obtain an insight into relevant documents. There will also be coordination with UNE, the Spanish standardization institute, which is a partner in the sister project AID4Greenest. This could be beneficial, especially when conducting standardization activities. One possible action could be handing in one or more CWAs as proposal for a new standard, as the lifetime of CWAs is restricted to 6 years, forcing the authors to propose a full standard once the CWA is published. To also support the implementation of the existing documents in the sister projects, further workshops and hands-on sessions are necessary. They will be mainly conducted by Fraunhofer IWM and DIN.

6 SUMMARY AND CONCLUSION

Generally, the present deliverable provides an overview of the standardization landscape related to DiMAT and therefore summarizes the results of Task 8.4 - Standardization. The knowledge about existing standards is important for the project since it enables the development of solutions which are compliant with the latest standards and further paves the way for upcoming liaison activities with relevant technical committees. Therefore, a standards database in the form of a dashboard was created, which includes 366 standards that could be relevant for the project. On the one hand, this dashboard offers the opportunity to search for specific standards. On the other hand, the overview of this dashboard provides the opportunity to identify standardization gaps and is therefore the basis for following activities. Within this deliverable, the dashboard was used to describe the standardization activities on international and European level related to DiMAT. Specific focus was put on areas that have a high relevance for the project. Besides listing relevant standards, this deliverable offers an overview of the TCs that are working on standards related to DiMAT. Since the interaction with relevant standardization committees is envisaged within DiMAT, an overview of current work items of the most relevant TCs is provided. In this context it is also worth mentioning the importance to really focus on specific areas within a broad field like digital technologies for advanced materials. The next steps include focusing further on these areas to initiate targeted standardization activities within DiMAT. Within DiMAT the contribution to ongoing or the initiation of new standardization activities is also sought. The workshop series will be continued to further analyze the need for standardization and thus the existence of possible standardization gaps in connection with DiMAT's work. This will then lead directly to the initiation of standardization activities. Altogether, through the work done in T8.4, awareness for standardization was raised throughout the consortium and the foundation was laid for the subsequent subtasks.

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APPENDIX A

DOCUMENT NO.	TITLE
ISO/IEC/IEEE 42020	Software, systems and enterprise - Architecture processes
DIN SPEC 91073	DIGIT - Standardization of data exchange between all stakeholders of the intermodal transport for efficient communication in digital future
ISO 9001	Quality management systems - Requirements
FprEN 9300-001	Aerospace series - LOTAR - LOng Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 001: Structure
EN 9300-002	Aerospace series - LOTAR - LOng Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 002: Requirements
EN 9300-003	Aerospace series - LOTAR - Long term archiving and retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 003: Fundamentals and concepts
EN 9300-004	Aerospace series - LOTAR - Long Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 004: Description methods
EN 9300-005	Aerospace series - LOTAR - LOng Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 005: Authentication and Verification
EN 9300-010	Aerospace series - LOTAR - LOng Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 010: Overview Data Flow
EN 9300-011	Aerospace series - LOTAR - Long Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 011: Reference process description "Data preparation"
EN 9300-012	Aerospace series - LOTAR Long Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 012: Reference process description "Ingest"
EN 9300-013	Aerospace series - LOTAR LOng Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 013: Reference process description "Archival Storage"
EN 9300-014	Aerospace series - LOTAR - LOng Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data - Part 014: Reference process description "Retrieval"
CWA 17349	Engineering materials - Electronic data interchange - Mechanical test data
CWA 17492	Predictive control and maintenance of data intensive industrial processes

CWA 17967	Guidelines for design of advanced Human-Robot Collaborative cells in personalized HRC systems
CWA 17284	Materials modelling - Terminology, classification and metadata
CWA 17815	Materials characterisation - Terminology, metadata and classification
CWA 17907	European Connected Factory Platform for Agile Manufacturing Interoperability (EFPFInterOp)
CWA 17960	ModGra - a Graphical representation of physical process models
EN ISO 14067	Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification (ISO 14067:2018)
CWA 16768	Framework for Sustainable Value Creation in Manufacturing Network
CWA 17354	Industrial Symbiosis: Core Elements and Implementation Approaches
CWA 17806	Design Circular Framework Setting - Composite recovery design solutions in the automotive industry
CWA 17807	Dismantling methods and protocols in a Circular Economy Framework - Composite recovery in the automotive industry
CWA 17935	Sustainable Nanomanufacturing Framework
EN 45553	General method for the assessment of the ability to remanufacture energy-related products
EN 45554	General methods for the assessment of the ability to repair, reuse and upgrade energy-related products
EN 45558	General method to declare the use of critical raw materials in energy-related products
EN 45559	Methods for providing information relating to material efficiency aspects of energy-related products
prEN ISO/IEC 15408-5	Information security, cybersecurity and privacy protection - Evaluation criteria for IT security - Part 5: Pre-defined packages of security requirements (ISO/IEC 15408-5:2022)
EN 17529	Data protection and privacy by design and by default
EN 17074	Glass in building - Environmental product declaration - Product category rules for flat glass products
EN 17289-1	Characterization of bulk materials - Determination of a size-weighted fine fraction and crystalline silica content - Part 1: General information and choice of test methods
EN 17289-2	Characterization of bulk materials - Determination of a size-weighted fine fraction and crystalline silica content - Part 2: Calculation method
EN 17289-3	Characterization of bulk materials - Determination of a size-weighted fine fraction and crystalline silica content - Part 3: Sedimentation method
EN 15344	Plastics - Recycled plastics - Characterization of Polyethylene (PE) recyclates
prEN 15346	Plastics - Recycled plastics - Characterization of poly(vinyl chloride) (PVC) recyclates

EN 15346	Plastics - Recycled plastics - Characterization of poly(vinyl chloride) (PVC) recyclates
EN 15348	Plastics - Recycled plastics - Characterization of poly(ethylene terephthalate) (PET) recyclates
CEN/TR 15351	Plastics - Guide for vocabulary in the field of degradable and biodegradable polymers and plastic items
EN 17228	Plastics - Bio-based polymers, plastics, and plastics products - Terminology, characteristics and communication
EN 17615	Plastics - Environmental Aspects - Vocabulary
EN ISO 22526-1	Plastics - Carbon and environmental footprint of biobased plastics - Part 1: General principles (ISO 22526-1:2020)
EN ISO 22526-2	Plastics - Carbon and environmental footprint of biobased plastics - Part 2: Material carbon footprint, amount (mass) of CO₂ removed from the air and incorporated into polymer molecule (ISO 22526-2:2020)
EN ISO 22526-3	Plastics - Carbon and environmental footprint of biobased plastics - Part 3: Process carbon footprint, requirements and guidelines for quantification (ISO 22526-3:2020)
CEN/TS 17276	Nanotechnologies - Guidelines for Life Cycle Assessment - Application of EN ISO 14044:2006 to Manufactured Nanomaterials
EN 16524	Mechanical products - Methodology for reduction of environmental impacts in product design and development
CEN/TR 17004	Mechanical products - Conditions to set up environmental communication models by recognizing sectorial particularities
EN 16751	Bio-based products - Sustainability criteria
EN 16760	Bio-based products - Life Cycle Assessment
EN 16785-1	Bio-based products - Bio-based content - Part 1: Determination of the bio-based content using the radiocarbon analysis and elemental analysis
EN 16785-2	Bio-based products - Bio-based content - Part 2: Determination of the bio-based content using the material balance method
CEN/TR 16957	Bio-based products - Guidelines for Life Cycle Inventory (LCI) for the End-of-life phase
EN ISO/ASTM 52924	Additive manufacturing of polymers - Qualification principles - Classification of part properties (ISO/ASTM 52924:2023)
prEN ISO/ASTM 52927	Additive manufacturing - General principles - Main characteristics and corresponding test methods (ISO/ASTM DIS 52927:2022)
prEN ISO/ASTM 52928	Additive manufacturing of metals - Feedstock materials - Powder life cycle management (ISO/ASTM DIS 52928:2022)
EN 10373	Determination of the physical and mechanical properties of steels using models

prEN 17988-1	Circular design of fishing gear and aquaculture equipment - Part 1: general requirements and guidance
prEN 17988-2	Circular design of fishing gear and aquaculture equipment - Part 2: User manual and labelling
prEN 17988-3	Circular design of fishing gear and aquaculture equipment - Part 3: Technical requirements
prEN 17988-4	Circular design of fishing gear and aquaculture equipment - Part 4: Environmental and circularity requirements and guidelines
prEN 17988-5	Circular design of fishing gear and aquaculture equipment - Part 5: Circular business model
prEN 17988-6	Circular design of fishing gear and aquaculture equipment - Part 6: Requirements and guidance for digitalization of information on gear and components
EN 50693	Product category rules for life cycle assessments of electronic and electrical products and systems
EN IEC 62832-2	Industrial-process measurement, control and automation - Digital factory framework - Part 2: Model elements (IEC 62832-2:2020)
EN IEC 62832-3	Industrial-process measurement, control and automation - Digital factory framework - Part 3: Application of Digital Factory for life cycle management of production systems (IEC 62832-3:2020)
DIN SPEC 16593-1	RM-SA - Reference Model for Industrie 4.0 Service Architectures - Part 1: Basic Concepts of an Interaction-based Architecture; Text in English
DIN SPEC 16592	Combining OPC Unified Architecture and Automation Markup Language
DIN SPEC 91345	Reference Architecture Model Industrie 4.0 (RAMI4.0)
DIN SPEC 91472	Remanufacturing (Reman) - Quality classification for circular processes
DIN EN IEC 62878-2-5	Device embedding assembly technology - Part 2-5: Guidelines - Implementation of a 3D data format for device embedded substrate (IEC 62878-2-5:2019); German version EN IEC 62878-2-5:2019
EN 303808 V 1.1.1	Environmental Engineering (EE) - Applicability of EN 45552 to EN 45559 methods for assessment of material efficiency aspects of ICT network infrastructure goods in the context of circular economy
ETSI GR CIM 017 V 1.1.1	Context Information Management (CIM) - Feasibility of NGSI-LD for Digital Twins
ETSI TR 101584 V 2.1.1	Machine-to-Machine communications (M2M) - Study on Semantic support for M2M Data
ETSI TS 102689 V 1.2.1	Machine-to-Machine communications (M2M) - M2M service requirements
ETSI TS 102689 V 2.1.1	Machine-to-Machine communications (M2M) - M2M service requirements
ETSI TS 102690 V 1.2.1	Machine-to-Machine communications (M2M) - Functional architecture
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ETSI TS 103268-1 V 1.1.1	SmartM2M - Smart Appliances Ontology and Communication Framework Testing - Part 1: Testing methodology
ETSI TS 103315 V 1.1.1	SmartM2M - Machine-to-Machine communications (M2M) - Interoperability Test Specification for ETSI M2M Primitives
ETSI TS 103410-5 V 1.1.2	SmartM2M - Extension to SAREF - Part 5: Industry and Manufacturing Domains
ETSI TR 103507 V 1.1.1	SmartM2M - SAREF extension investigation - Requirements for industry and manufacturing domains
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ETSI TS 103264 V 1.1.1	SmartM2M - Smart Appliances - Reference Ontology and oneM2M Mapping
ETSI TS 103264 V 2.1.1	SmartM2M - Smart Appliances - Reference Ontology and oneM2M Mapping
ETSI TS 103264 V 3.1.1	SmartM2M - Smart Applications - Reference Ontology and oneM2M Mapping
ETSI TR 103535 V 1.1.1	SmartM2M - Guidelines for using semantic interoperability in the industry
ETSI TR 103537 V 1.1.1	SmartM2M - PlugtestsTM preparation on Semantic Interoperability
ETSI TR 103781 V 1.1.1	SmartM2M - Study for SAREF ontology patterns and usage guidelines
ETSI TR 103783 V 1.1.1	SmartM2M - SAREF: SDT interoperability and oneM2M base ontology alignment
IEC 62656-1*CEI 62656-1	Standardized product ontology register and transfer by spreadsheets - Part 1: Logical structure for data parcels
IEC/TS 62656-2*CEI/TS 62656-2	Standardized product ontology register and transfer by spreadsheets - Part 2: Application guide for use with IEC CDD
IEC 62656-3*CEI 62656-3	Standardized product ontology register and transfer by spreadsheets - Part 3: Interface for Common Information Model
IEC 62656-5*CEI 62656-5	Standardized product ontology register and transfer by spreadsheets - Part 5: Interface for activity description
IEC 62656-8*CEI 62656-8	Standardized product ontology register and transfer by data parcels - Part 8: Web service interface for data parcels
IEC 65C/1269/CD*CEI 65C/1269/CD*IEC 62541-15*CEI 62541-15	OPC Unified Architecture - Part 15: Safety
IEC/TR 62541-1*CEI/TR 62541-1	OPC unified architecture - Part 1: Overview and concepts
IEC 62541-10*CEI 62541-10	OPC unified architecture - Part 10: Programs
IEC 62541-100*CEI 62541-100	OPC Unified Architecture Specification - Part 100: Device Interface

IEC 62541-11*CEI 62541-11	OPC unified architecture - Part 11: Historical Access
IEC 62541-12*CEI 62541-12	OPC unified architecture - Part 12: Discovery and global services
IEC 62541-13*CEI 62541-13	OPC Unified Architecture - Part 13: Aggregates
IEC 62541-14*CEI 62541-14	OPC unified architecture - Part 14: PubSub
IEC/TR 62541-2*CEI/TR 62541-2	OPC unified architecture - Part 2: Security Model
IEC 62541-3*CEI 62541-3	OPC unified architecture - Part 3: Address Space Model
IEC 62541-4*CEI 62541-4	OPC unified architecture - Part 4: Services
IEC 62541-5*CEI 62541-5	OPC unified architecture - Part 5: Information Model
IEC 62541-6*CEI 62541-6	OPC unified architecture - Part 6: Mappings
IEC 62541-7*CEI 62541-7	OPC unified architecture - Part 7: Profiles
IEC 62541-8*CEI 62541-8	OPC unified architecture - Part 8: Data access
IEC 62541-9*CEI 62541-9	OPC unified architecture - Part 9: Alarms and Conditions
IEC 62714-1*CEI 62714-1	Engineering data exchange format for use in industrial automation systems engineering - Automation markup language - Part 1: Architecture and general requirements
IEC 62714-2*CEI 62714-2	Engineering data exchange format for use in industrial automation systems engineering - Automation markup language - Part 2: Semantics libraries
IEC 62714-3*CEI 62714-3	Engineering data exchange format for use in industrial automation systems engineering - Automation markup language - Part 3: Geometry and kinematics
IEC 62714-4*CEI 62714-4	Engineering data exchange format for use in industrial automation systems engineering - Automation markup language - Part 4: Logic
IEC 62714-4 Corrigendum 1*CEI 62714-4 Corrigendum 1	Engineering data exchange format for use in industrial automation systems engineering - Automation markup language - Part 4: Logic; Corrigendum 1
IEC 62714-5*CEI 62714-5	Engineering data exchange format for use in industrial automation systems engineering - Automation markup language - Part 5: Communication
IEC/PAS 63178*CEI/PAS 63178	Smart manufacturing service platform - Service-oriented integration requirements of the manufacturing resource/capability
IEC 63365*CEI 63365	Industrial process measurement, control and automation - Digital nameplate
IEC SyCSM/81/DTS*CEI SyCSM/81/DTS*IEC SRD 63456*CEI SRD 63456	Systems Reference Deliverable (SRD) - Navigation Tools for Smart Manufacturing

IEC 111/702/CD*CEI 111/702/CD*IEC/TS 63428*CEI/TS 63428	Guidance on material circularity considerations in environmentally conscious design
IEC 3/1606/DPAS*CEI 3/1606/DPAS*IEC/PAS 63485*CEI/PAS 63485	Intelligent Information Request and Delivery Specification (iiRDS) - A process model for information architecture
IEC 62832-1*CEI 62832-1	Industrial-process measurement, control and automation - Digital factory framework - Part 1: General principles
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IEC 65/992/CD*CEI 65/992/CD*IEC 63278-2*CEI 63278-2	Asset Administration Shell for Industrial Applications - Part 2: Information meta model
IEC/TR 63283-1*CEI/TR 63283-1	Industrial-process measurement, control and automation - Smart manufacturing - Part 1: Terms and definitions
IEC/TR 63283-2*CEI/TR 63283-2	Industrial-process measurement, control and automation - Smart manufacturing - Part 2: Use cases
IEC/TR 63283-3*CEI/TR 63283-3	Industrial-process measurement, control and automation - Smart manufacturing - Part 3: Challenges for cybersecurity
IEC/TR 63283-4*CEI/TR 63283-4	Industrial-process measurement, control and automation - Smart Manufacturing - Part 4: Recommendations for the usage of new technologies
IEC/TR 63283-5*CEI/TR 63283-5	Industrial-process measurement, control and automation - Smart manufacturing - Part 5: Market and innovation trends analysis
IEC 65/812/DTR*CEI 65/812/DTR*IEC/TR 63319*CEI/TR 63319	A meta-modelling analysis approach to smart manufacturing reference models
IEC/TR 63283-2*CEI/TR 63283-2	Industrial-process measurement, control and automation - Smart manufacturing - Part 2: Use cases
IEC/TR 63051*CEI/TR 63051	Documentation on design automation subjects - Mathematical algorithm hardware description languages for system level modeling and verification (HDLMath)
DIN EN ISO/IEC 27001	Information security, cybersecurity and privacy protection - Information security management systems - Requirements (ISO/IEC 27001:2022); German and English version prEN ISO/IEC 27001:2023
DIN SPEC 3103	Blockchain and distributed ledger technologies in application scenarios for Industrie 4.0
DIN SPEC 32792	Semantic Data Annotations to Support AI-enabled Data Processing; Text in English

DIN EN 10373	Determination of the physical and mechanical properties of steels using models; German version EN 10373:2021
ISO/IEC TS 23884	Information technology - Computer graphics, image processing and environmental data representation - Material property and parameter representation for model-based haptic simulation of objects in virtual, mixed and augmented reality (VR/MAR)
ISO/IEC 15408-1	Information security, cybersecurity and privacy protection - Evaluation criteria for IT security - Part 1: Introduction and general model
ISO/IEC 20547-4	Information technology - Big data reference architecture - Part 4: Security and privacy
ISO/IEC TR 22216	Information security, cybersecurity and privacy protection - New concepts and changes in ISO/IEC 15408:2022 and ISO/IEC 18045:2022
ISO/IEC 27005	Information security, cybersecurity and privacy protection - Guidance on managing information security risks
ISO/IEC 27014	Information security, cybersecurity and privacy protection - Governance of information security
ISO/IEC 27400	Cybersecurity - IoT security and privacy - Guidelines
ISO/IEC TR 27550	Information technology - Security techniques - Privacy engineering for system life cycle processes
ISO/IEC TR 27563	Security and privacy in artificial intelligence use cases - Best practices
ISO/IEC DIS 27701	Security techniques - Extension to ISO/IEC 27001 and ISO/IEC 27002 for privacy information management - Requirements and guidelines
ISO/IEC 27701	Security techniques - Extension to ISO/IEC 27001 and ISO/IEC 27002 for privacy information management - Requirements and guidelines
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ISO/IEC 29100	Information technology - Security techniques - Privacy framework
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ISO/IEC 29190	Information technology - Security techniques - Privacy capability assessment model
ISO/IEC 19763-1	Information technology - Metamodel framework for interoperability (MFI) - Part 1: Framework
ISO/IEC 21838-1	Information technology - Top-level ontologies (TLO) - Part 1: Requirements
ISO/IEC 21838-2	Information technology - Top-level ontologies (TLO) - Part 2: Basic Formal Ontology (BFO)
ISO/IEC 21838-3	Information technology - Top-level ontologies (TLO) - Part 3: Descriptive ontology for linguistic and cognitive engineering (DOLCE)
ISO/IEC 21838-4	Information technology - Top-level ontologies (TLO) - Part 4: TUpper
ISO/IEC TR 20943-6	Information technology - Procedures for achieving metadata registry content consistency - Part 6: Framework for generating ontologies

IEC JTC1-SC41/334/CDV*CEI JTC1-SC41/334/CDV*ISO/IEC 20924	Internet of Things (IoT) and Digital Twin - Vocabulary
IEC JTC1-SC41/335/DTR*CEI JTC1-SC41/335/DTR*ISO/IEC TR 30172	Digital Twin - Use cases
IEC JTC1-SC41/355/CD*CEI JTC1-SC41/355/CD*ISO/IEC 30178	Internet of Things (IoT) - Data format, value and coding
IEC JTC1-SC41/357/CD*CEI JTC1-SC41/357/CD*ISO/IEC TR 30194	Internet of Things (IoT) and Digital Twin - Best practices for use case projects
IEC JTC1-SC41/362/FDIS*CEI JTC1-SC41/362/FDIS*ISO/IEC 30173	Digital twin - Concepts and terminology
ISO/IEC 21823-3	Internet of things (IoT) - Interoperability for IoT systems - Part 3: Semantic interoperability
ISO/IEC TR 30166	Internet of things (IoT) - Industrial IoT
ISO/IEC 22989	Information technology - Artificial intelligence - Artificial intelligence concepts and terminology
ISO/IEC 23053	Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML)
ISO/IEC TR 24030	Information technology - Artificial intelligence (AI) - Use cases
ISO/IEC TS 4213	Information technology - Artificial intelligence - Assessment of machine learning classification performance
ISO/IEC DIS 5259-1	Artificial intelligence - Data quality for analytics and machine learning (ML) - Part 1: Overview, terminology, and examples
ISO/IEC DIS 5259-2	Artificial intelligence - Data quality for analytics and machine learning (ML) - Part 2: Data quality measures
ISO/IEC DIS 5259-3	Artificial intelligence - Data quality for analytics and machine learning (ML) - Part 3: Data quality management requirements and guidelines
ISO/IEC DIS 5259-4	Artificial intelligence - Data quality for analytics and machine learning (ML) - Part 4: Data quality process framework
ISO/IEC DIS 5392	Information technology - Artificial intelligence - Reference architecture of knowledge engineering
ISO/IEC/IEEE 24748-1	Systems and software engineering - Life cycle management - Part 1: Guidelines for life cycle management

ISO/IEC/IEEE DIS 24748-1	Systems and software engineering - Life cycle management - Part 1: Guidelines for life cycle management
ISO/IEC/IEEE FDIS 24748-1	Systems and software engineering - Life cycle management - Part 1: Guidelines for life cycle management
ISO/IEC 25001	Systems and software engineering - Systems and software Quality Requirements and Evaluation (SQuaRE) - Planning and management
ISO/IEC 25051	Software engineering - Systems and software Quality Requirements and Evaluation (SQuaRE) - Requirements for quality of Ready to Use Software Product (RUSP) and instructions for testing
ISO/IEC 26552	Software and systems engineering - Tools and methods for product line architecture design
ISO/IEC TR 29119-11	Software and systems engineering - Software testing - Part 11: Guidelines on the testing of AI-based systems
ISO/IEC/IEEE 29148	Systems and software engineering - Life cycle processes - Requirements engineering
ISO/IEC/IEEE 42010	Software, systems and enterprise - Architecture description
ISO 11442	Technical product documentation - Document management
ISO 16792	Technical product documentation - Digital product definition data practices
ISO 12135	Metallic materials - Unified method of test for the determination of quasistatic fracture toughness
ISO 10303-243	Industrial automation systems and integration - Product data representation and exchange - Part 243: Application protocol: For modelling and simulation information in a collaborative systems engineering context (MoSSEC)
ISO/TS 10303-4443	Industrial automation systems and integration - Product data representation and exchange - Part 4443: Domain model: For modelling and simulation information in a collaborative systems engineering context (MoSSEC)
ISO 13281	Industrial automation systems - Manufacturing Automation Programming Environment (MAPLE) - Functional architecture
ISO 15531-1	Industrial automation systems and integration - Industrial manufacturing management data - Part 1: General overview
ISO 15531-31	Industrial automation systems and integration - Industrial manufacturing management data - Part 31: Resource information model
ISO 15531-32	Industrial automation systems and integration - Industrial manufacturing management data: Resources usage management - Part 32: Conceptual model for resources usage management data
ISO 15531-42	Industrial automation systems and integration - Industrial manufacturing management data - Part 42: Time Model

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ISO 15531-43	Industrial automation systems and integration - Industrial manufacturing management data - Part 43: Manufacturing flow management data: Data model for flow monitoring and manufacturing data exchange
ISO 15531-44	Industrial automation systems and integration - Industrial manufacturing management data - Part 44: Information modelling for shop floor data acquisition
ISO 16100-1	Industrial automation systems and integration - Manufacturing software capability profiling for interoperability - Part 1: Framework
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ISO 16100-5	Industrial automation systems and integration - Manufacturing software capability profiling for interoperability - Part 5: Methodology for profile matching using multiple capability class structures
ISO 16100-6	Industrial automation systems and integration - Manufacturing software capability profiling for interoperability - Part 6: Interface services and protocols for matching profiles based on multiple capability class structures
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ISO 20140-1	Automation systems and integration - Evaluating energy efficiency and other factors of manufacturing systems that influence the environment - Part 1: Overview and general principles
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ISO 20140-5	Automation systems and integration - Evaluating energy efficiency and other factors of manufacturing systems that influence the environment - Part 5: Environmental performance evaluation data
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ISO 17296-2	Additive manufacturing - General principles - Part 2: Overview of process categories and feedstock
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ISO/ASTM 52907	Additive manufacturing - Feedstock materials - Methods to characterize metal powders
ISO/ASTM 52915	Specification for additive manufacturing file format (AMF) Version 1.2
ISO/ASTM TR 52916	Additive manufacturing for medical - Data - Optimized medical image data
ISO/ASTM DIS 52927	Additive manufacturing - General principles - Main characteristics and corresponding test methods

ISO/ASTM 52950	Additive manufacturing - General principles - Overview of data processing
ISO/ASTM DIS 52928	Additive manufacturing of metals- Feedstock materials - Powder life cycle management
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ISO/DIS 59010	Circular Economy — Guidance on the transition of business models and value networks
ISO/DIS 59020	Circular economy - Measuring and assessing circularity
ISO 5157	Textiles - Environmental aspects - Vocabulary
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ISO 22841	Composites and reinforcements fibres - Carbon fibre reinforced plastics(CFRPs) and metal assemblies - Determination of the tensile lap-shear strength
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ISO 4410	Test methods for the experimental characterization of in-plane permeability of fibrous reinforcements for liquid composite moulding
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ISO 16620-3	Plastics - Biobased content - Part 3: Determination of biobased synthetic polymer content

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ISO/DIS 16620-4	Plastics - Biobased content - Part 4: Determination of biobased mass content
ISO 16620-4	Plastics - Biobased content - Part 4: Determination of biobased mass content
ISO 17088	Plastics - Organic recycling - Specifications for compostable plastics
ISO 22526-1	Plastics - Carbon and environmental footprint of biobased plastics - Part 1: General principles
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ISO 22526-3	Plastics - Carbon and environmental footprint of biobased plastics - Part 3: Process carbon footprint, requirements and guidelines for quantification
ISO 22526-4	Plastics - Carbon and environmental footprint of biobased plastics - Part 4: Environmental (total) footprint (Life cycle assessment)
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ITU-T Y.4563	Requirements and functional model to support data interoperability in Internet of things environments
DIN-Fachbericht 108	Guide for the inclusion of environmental aspects in product standardization and development; German and English Version
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DIN 51916	Testing of carbonaceous materials - Determination of apparent density after tamping - Solid materials
DIN 51918	Testing of carbonaceous materials - Determination of bulk density and the open porosity

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