Report D1.13
"Ontology-based digital marketplaces for Industry Commons v2"

Grant Agreement: 958371

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Report D1.13
"Ontology-based digital marketplaces for Industry Commons v2"

Work Package	WP1 | Cooperation
Task	T1.5 | Ontology-based digital-marketplaces cooperation
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Glossary of terms

Item	Description
AMI 2030	Advanced Materials 2030 Initiative
BEDA	Bureau Of European Design Associations
DSSC	Data Spaces Support Centre
DOME 4.0	Digital Open Marketplace Ecosystem 4.0
EMMO	Elementary Multiperspective Material Ontology
FAIR	Findable, Accessible, Interoperable and Reusable
FW	Focused Workshop
HW	Horizontal Workshop
IP	Intellectual Property
MM	Materials and Manufacturing

MLO	Mid-Level Ontology
PMD	Platform Material Digital
RDA	Research Data Alliance
TLO	Top-Level Ontology
TRL	Technology Readiness Level
TRO	Top Reference Ontology
OCES	Ontology Commons EcoSystem
VIMMP	Virtual Materials MarketPlace

Keywords

Ontology; Data; Standardisation; Digital marketplaces; Industry Commons

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Executive Summary

This document reports on the status of the cooperation between OntoCommons and the digital marketplaces, combining and summarizing outcomes from meetings with the marketplace projects (DOME 4.0, MarketPlace, and VIMMP), and from dedicated OntoCommons workshop activities (namely, focused workshop FW1.2 - *Towards Materials and Manufacturing Commons* and the related *Insights from the workshop "Towards Materials and Manufacturing Commons"* session in the second horizontal OntoCommons workshop). Input from other recent events and activities in this area is included too.

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1. Introduction

Within its general aim of supporting the adoption of ontology-based standardised documentation for Industry Commons, one of OntoCommons' specific objectives is to support the adoption of such technology and results by the *digital marketplace* projects. All the activities in this line fall under Task 1.5, "Ontology-based digital-marketplaces cooperation" that runs over the whole project duration. The present document is a follow up of a previous one produced at M18 (OntoCommons D1.12[1]) and refers to activities that took place in the second half of the project (M18-M36, i.e., April 2022-October 2023). The digital marketplace projects involved in the collaboration in this second phase of Task 1.5, with their timelines and grant agreement (GA) numbers, are:

- Digital Open Marketplace Ecosystem 4.0 (DOME 4.0)[2] [Dec 2020 – Nov 2024, GA 953163]
- MARKET4.0[3] [Nov 2018 – Apr 2022, GA 822064]
- MarketPlace[4] [Jan 2018 – Jun 2023, GA 760173]
- Virtual Materials MarketPlace (VIMMP)[5] [Jan 2018 – Jun 2022, GA 760907].

We recall that MarketPlace and VIMMP focus on materials modelling, MARKET4.0 on equipment for manufacturing, and the more recent DOME 4.0 on industrial data[6]. As pointed out in D1.12, the uptake of semantic technologies in these marketplaces is varied. And on the other side OntoCommons EcoSystem (OCES) has been developed in parallel. At the time of writing, there are by now many tangible results by OntoCommons that are closely relevant for the marketplaces (as the Industry Portal[7] and the Bridge Concept templates[8]) and the final batch of reports are being completed (including D2.9 "TRO/MLO Guidelines and Recommendations" and D3.8 "Report on the finalized Review of Domain Interoperability").

The two projects from the NMBP-25-2017 call have by now been finalized (VIMMP in June 2022, and the MarketPlace in June 2023[9]), as well as the MARKET 4.0 project, whereas the DOME 4.0 project is

[1] OntoCommons D1.12, "Ontology-based digital marketplaces for Industry Commons v1". Available at https://cordis.europa.eu/project/id/958371/results .

[2] https://dome40.eu/

[3] http://market40.eu/ Note: In this period, MARKET 4.0 has been involved only indirectly, *via* its presence as a demonstrator within the DOME 4.0 project.

[4] https://www.the-marketplace-project.eu/

[5] https://www.vimmp.eu/

[6] MarketPlace and VIMMP belong to the call NMBP-25-2017 ("Next generation system integrating tangible and intangible materials model components to support innovation in industry"), whereas MARKET4.0 belongs to DT-NMBP-20-2018 ["A digital 'plug and produce' online equipment platform for manufacturing" (IA)] and DOME 4.0 to DT-NMBP-40-2020 ["Creating an open market place for industrial data" (RIA)].

[7] http://industryportal.enit.fr/

[8] https://github.com/OntoCommons/OntologyFramework/blob/main/bridge-concept-template.md

[9] The project duration was extended as compared to what stated in D1.12.

still ongoing and is well positioned to make best use of the legacy from the others[10]. As suggested at the end of D1.12, an event has been organized by OntoCommons to collect the lessons learnt by these projects (cf. Berlin event, FW 1.2). Beside the digital marketplaces, there are other entities/projects that face overlapping challenges and whose developments are relevant here as well: Data Spaces (e.g., DSSC), Open Innovation Platforms (e.g., OpenModel), Open Translation Environments (e.g., OntoTrans), Open Science Platforms, just to mention some.[11]

We note that, in general, in this document we avoid repeating the insights already pointed out in D1.12, and preferentially report on additional findings. Therefore, it complements, rather than replacing D1.12. Also, we *focus* here *on cooperation aspects*, more than the individual results of the various involved projects, for which we point the reader to the corresponding reports. With this *caveat* in mind, the present document is structured as follows: in Section 2 we list the collaboration events, in Section 3 we give highlights from the discussions, then draw our conclusions in Section 4. In Appendix A, we include a summary of OntoCommons FW 1.2, and an extract of survey results from DOME 4.0 Hackathon 1 can be found in Appendix B.

2. Cooperation events

In this section we list the events that have contributed to the content of this document and point the reader to other relevant OntoCommons deliverables.

2.1. Events this document focuses upon

- OntoCommons Focused workshop FW1.2 - *Towards Materials and Manufacturing Commons - the enablers Digital Marketplaces, FAIR Principles and Ontologies*, Berlin (Germany) and on-line, 4th-6th April 2023, organized by Fraunhofer IWM. [Event webpage, where presentations slides are available too: https://ontocommons.eu/news-events/events/towards-materials-and-manufacturing-commons-enablers-digital-marketplaces-fair . Recordings can be found at: https://www.youtube.com/playlist?list=PL-cwgiwYXckMVegcUtTIp7QbAXNvffx_c]
- *Ontology-based digital marketplaces for Industry Commons* session, 13th June 2023, within the second horizontal OntoCommons workshop (HW), Oslo (Norway) and on-line, 13th–16th June 2023. [Event webpage, where presentations slides will available too: https://ontocommons.eu/news-events/events/second-global-workshop-ontocommons-addressing-challenges-industry-50-transition . For recordings of day 1, see: https://www.youtube.com/playlist?list=PL-cwgiwYXckNoAyVhE8Qb699YAoUvDkmA .]

[10] Also thanks to the presence of project partners and teams that also participate in OntoCommons (as BOSCH, GCL, UNIBO, UKRI), and institutions that have been and are strongly involved in marketplaces and OIP projects (as, GCL, SINTEF, FRAUNHOFER, UNIBO, UKRI).

[11] For a recent related event, see e.g., OIP 2023 - Open Innovation Conference, Luxembourg, 19-20 October 2023 [Event webpage: https://oip-2023.eu/]

- OntoCommons – DOME 4.0 coordination meetings, on-line, organized by BOSCH (who are a beneficiary of both projects).

2.2. Other events providing input

- *DOME 4.0 Industrial Engagement Open day and Hackathon,* Bologna (Italy) and on-line, 17th-19th January 2023 [Event webpage: https://dome40.eu/dome-40-industrial-engagement-open-day-and-hackathon-1][12]
- EMMC IW (International Workshop) 2023, Vienna (Austria), April 2023 [event webpage: https://emmc.eu/emmc-2023/] Note: DOME 4.0, MarketPlace and OntoCommons presented posters at the event[13]
- *DOME 4.0 2nd Industrial Engagement Open day and Hackathon,* Leuven (Belgium), and online, 10th-12th October 2023. [Event webpage: https://dome40.eu/dome-40-join-second-hackathon-and-industrial-engagement-open-day]
- OntoTrans 2nd open workshop: "Making Connections" to improve the Efficiency and Effectiveness of Innovation in Materials and Manufacturing, 7th September 2023 [Event webpage: https://ontotrans.eu/ontotrans-2nd-open-workshop/]

2.3. Related OntoCommons deliverables / reports

- OntoCommons D1.12 - "Ontology-based digital marketplaces for Industry Commons v1". Available at https://cordis.europa.eu/project/id/958371/results .
- OntoCommons D6.6 - *"Report on the outcomes on the second OntoCommons Horizontal Workshop as well as with Synergies with related projects"* (to appear on Zenodo)
- *"A report on the Workshop "Towards Materials and Manufacturing Commons - the enablers Digital Marketplaces, FAIR Principles and Ontologies"* based on the OntoCommons Focused workshop FW1.2 (to appear on Zenodo)

3. Highlights of developments and discussions

In this section we summarize recent technical developments from the marketplaces and from related projects and platforms. Then, we report on the key outcomes from Berlin FW 1.2, focusing especially on discussions and interactive sessions.[14] .

[12] Both DOME 4.0 Industrial Open days and Hackathons will be part of DOME 4.0 deliverables D6.4 and D6.5 (to appear on Zenodo, 2024)

[13] See dedicated page on the event website: https://emmc.eu/emmc-2023/contributions/

[14] For a detailed report on all the individual talks, please see the 3rd document listed in Sec 2.3 above.

3.1. Developments on the technical side

Within the DOME 4.0 project, there have been two deliverables associated with ontologies: DOME 4.0 D3.1 **"Semantic data exchange ontology"** and DOME 4.0 D3.2 **"Ecosystem information model ontology"**[15]. The first one, D3.1, presents a semantic enhancement of existing metadata schema, in particular a mapping of the widely used DCAT RDF vocabulary to the richer semantic framework of EMMO. It is to be used also within other open innovation and marketplaces projects. The second one, D3.2, describes the DOME 4.0 Ecosystem Ontology, which includes the concepts needed on the DOME 4.0 platform to integrate multiple sources of data and services. A dedicated alignment module to the EMMO has been developed as well.

As part of the OntoCommons – DOME 4.0 collaboration, **ontology evaluation guidelines** developed within OntoCommons have been recently applied to DOME Ecosystem ontology and to the more mature use-case related ontologies. This effort has been led by BOSCH and ENIT colleagues and has involved colleagues from both projects, *via* discussions and collaborative editing of a document, and has led to concrete feedback for possible improvements. We underline that two aspects of this collaboration were valuable: both providing the guidelines and engaging in dedicated two-way discussions (as the insight that can be provided by automatic tools is useful, but necessarily partial). The guidelines, covering multiple aspects of ontology quality, and examples of their application within DOME 4.0 will be soon presented at the *Second International Workshop on Semantic Industrial Information Modelling* (SemIIM)[16] (7th November 2023), co-located with ISWC 2023[17], in a dedicated session called "H2020 EU Projects Presentations: OntoCommons and DOME4.0". Moreover, they will be described in detail in OntoCommons D2.9 (to appear on Zenodo soon) and in the future DOME 4.0 deliverable D5.2 (to appear on Zenodo, 2024).

DOME 4.0 platform has advanced in this period, with various developments broadly relevant for interoperability between and within platform (e.g., the **connector template**[18] for the third-party tools and services to connect to DOME platform, and the **semantic broker service**[19]).

Within OntoTrans and OpenModel projects, the **OTE-API framework** was further developed and implemented[20]. Moreover, **various ontologies** relevant for digital marketplaces in the area of materials (most of which were already mentioned in D1.12) **have been further developed,** including: the

[15] Both DOME 4.0 D3.1 and D3.2 are available at https://dome40.eu/deliverables .
[16] https://sites.google.com/view/semiim-2023/home
[17] ISWC 2023: 22nd International Semantic Web Conference, https://iswc2023.semanticweb.org/
[18] DOME 4.0 D3.7 "Semantic API container component", submitted May 2023. Repository: https://github.com/DOME-4-0/Tools-Services-Plugin-Template
[19] DOME 4.0 D3.3 "Semantic broker service", Submitted July 2023. Available at https://dome40.eu/deliverables
[20] For a recent presentation about this, see e.g.: "Connecting Knowledge Sources and Data Pipelining with OTEAPI and OTElib", by Jesper Friis (SINTEF, Norway) available at https://ontotrans.eu/wp-content/uploads/2023/09/4.Jesper_Connecting_Second_Open_OntoTrans_Workshop.pdf

Characterisation Methodology Domain Ontology CHAMEO[21]; EMMO itself[22] with disciplines like metrology (including QUDT); MAEO has been updated and a paper published[23]; MDO (Materials Design Ontology) has been aligned with EMMO in an OntoCommons demonstrator, proposed by colleagues at Linköping University; within the VIMMP project, the VIMMP set of ontologies[24] has also been further developed.

As a related topic that has attracted interest recently, we finally point out **Scientific Knowledge Graph** (SKG), connecting entities like authors, publications, datasets (e.g., see the Open Aire Graph https://graph.openaire.eu and discussions within the RDA[25]).

3.2. Highlights of discussions (from Berlin OC FW1.2 event)

In this section we distil the discussions that took place in the FW1.2 event. This is complemented by the following one that focuses on the MM Commons.

- **Keywords**
  - Marketplaces
  - Data Spaces and focus on material data spaces
  - Materials Commons
  - Design (cf. BEDA session), modelling, manufacturing
  - FAIRness
  - Knowledge Management Translator (A proposed role)
- **Highlights**
  - List of FAIR projects (Including EOSC and GO FAIR)
  - List of MM "platforms"/data spaces, including digital marketplaces (DOME 4.0, MDP, etc)
  - EC: Green deal and circular economy
  - (Need for) Training
  - Technical and cultural/human aspects
  - Trust, ownership
  - (Semantics) Rigour vs utility
  - Creativity needs flexibility

[21] https://github.com/emmo-repo/domain-characterisation-methodology
[22] For the most recent version of EMMO (1.0.0-beta5), see: https://github.com/emmo-repo/EMMO/tree/1.0.0-beta5
[23] "MAEO: An Ontology for Modeling Agents, Experts and Expertise within an Open Online Materials Modeling MarketPlace", by Goldbeck & Toti, in JOWO 2021 proceedings, http://ceur-ws.org/Vol-2969/
[24] https://gitlab.com/vimmp-semantics/vimmp-ontologies
[25] E.g., see the Interest Group https://www.rd-alliance.org/groups/open-science-graphs-fair-data-ig and the recent RDA Data Week 2023, Salzburg [Event website: https://www.rd-alliance.org/plenaries/international-data-week-2023-salzburg]

  - Prescriptive *vs* open frameworks
  - Sharing and IP
  - "Ontology learning"
  - Theory *vs* practice
  - Standards and ontologies

- **Bottlenecks for semantics**
  - Bridging between domain experts and ontologists, manual work -> Intermediate representations needed. Training and technology as solutions
  - AI and ontology engineering (a.k.a. "Ontology learning" in the past)
  - AI can help to acquire knowledge and generate a first set of terms.
  - It would be useful to have bridging support from AI, with provenance links (e.g., suggest X based on text Y)
  - Logic, alignment, trust: currently AI cannot do this properly
  - Human in the loop needed, for background knowledge (both domain and ontology language rules)
- **Layers of data**
  - Different concerns for computer scientists, ontologists, domain experts.
  - Terms vs concepts/semantics. Terms, relations, definitions, logics, applications.
  - FAIRness, FAIRness of content, data quality: some overlap, but distinct aspects
- **Design and co-creation**
  - Design has changed: entire product life is data assisted and data driven (also very early stages)
  - User at the center: right response for the right user, flexible interfaces
  - Involve users in product co-design (early adopters, sources of knowledge)
  - Importance of visualization of ontologies/knowledge graphs
- **Sharing and IP**
  - Pre-competitive collaboration on commons pain points

3.3. Towards Materials & Manufacturing Commons (from Berlin OC FW1.2 event)

Participants of the Berlin event were asked about the status of their materials data today and to give realistic visions for the future MM Commons. Below we show an extract of the answers, full results are available on the event website[26]. From this self-assessment, we see that **data is currently very little**

[26] Two interactive sessions were held in the Berlin event, in day 1 and day 3. Slides can be found at https://ontocommons.eu/sites/default/files/2023-06/OntoCommons%20FW%20Berlin_Mentimeter_with_results.pdf and https://www.ontocommons.eu/

open, FAIR, linked, semantically enriched, human friendly and machine-readable. To get an idea of the overall audience profile it included (from answers on day 1) a large fraction of ontologists and application developers[27], with "manufacturing" being the main expertise topic (day 1) and "researcher" the most common role (day 3).

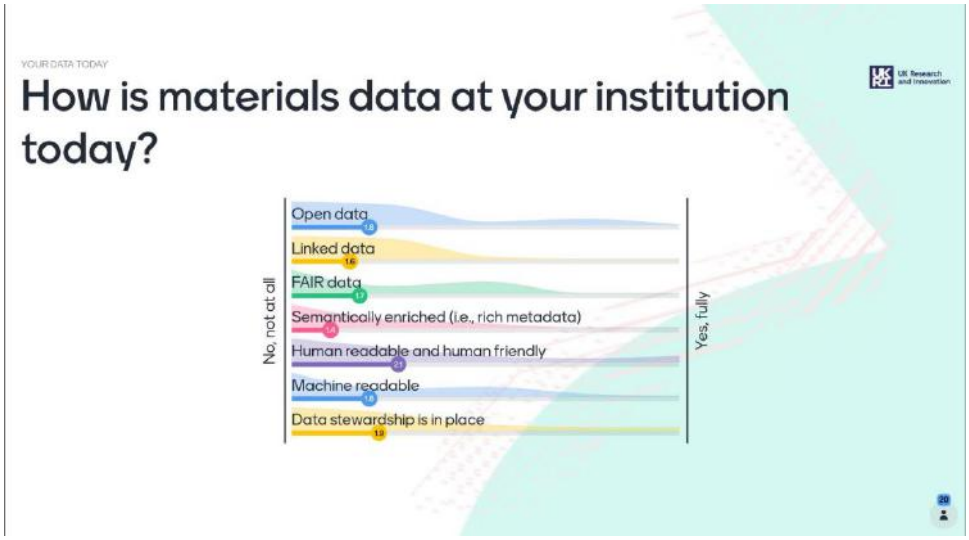

Figure 1 - Snapshot from the Berlin Mentimeter presentation day 3, results for question Q2

Concerning the **future of data exchange in 2030**, multiple modalities and dimensions of data exchange are expected to be very relevant and multiple governance models are considered to be likely (centralized and federated, national and European).

https://ontocommons.eu/sites/default/files/2023-06/OntoCommons%20FW%20Berlin%20day%203_with_results.pdf respectively.

[27] In Berlin event day 1, the answers to the question "In which role are you here today?": Ontologist (34%), Database expert (4%), Application developer (14%), End user (7%), Business developer (3%), Other (39%).
In the same survey, the answers to the question "In your institute/company semantic technologies...", were: "are heavily used (48%), "start to be used (42%), "are not used yet" (10%). The sample included 29 people for both questions.

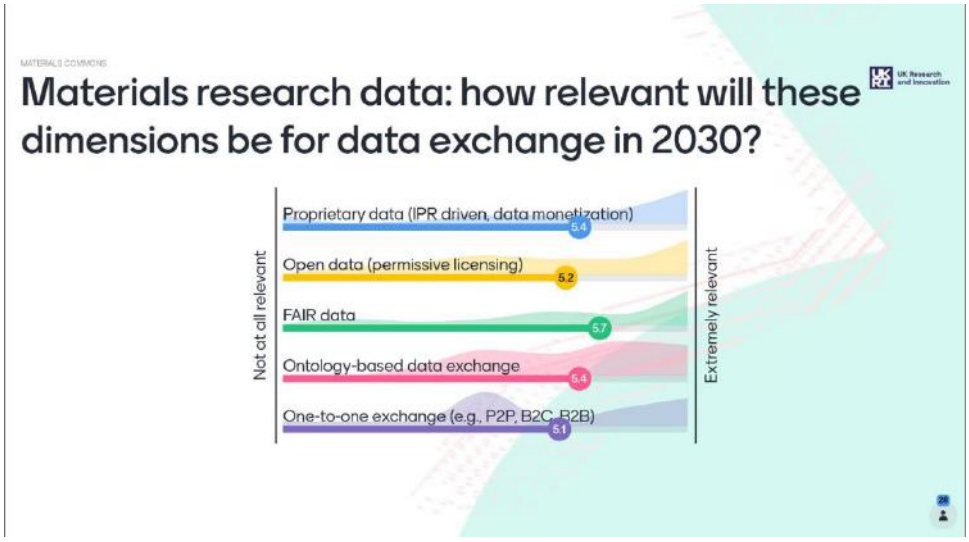

Figure 2 - Snapshot from the Berlin Mentimeter presentation, day 1, results for question Q5

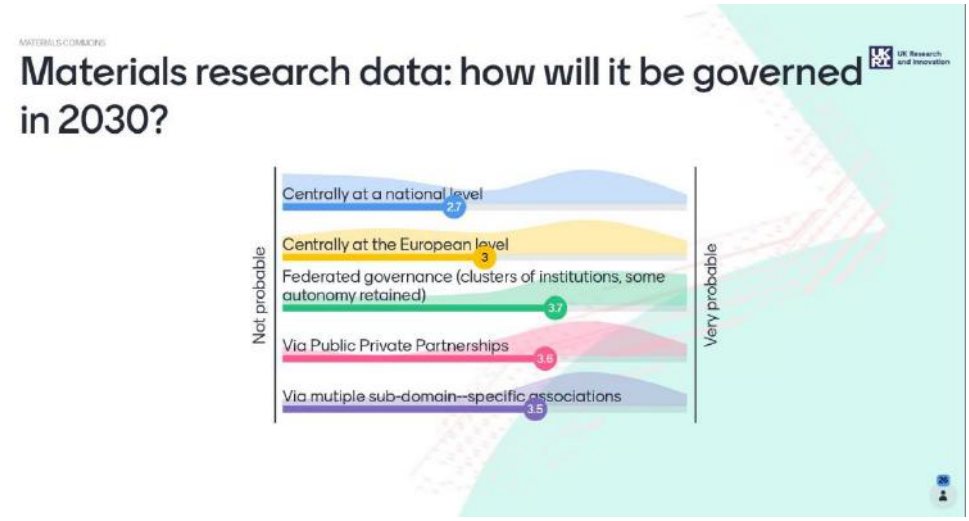

Figure 3 - Snapshot from the Berlin Mentimeter presentation, day 1, results for question Q6

Participants were also asked to **rank the attractive features and barriers towards joining digital marketplaces, from the perspective of users/providers of data/software.** These results largely confirm those obtained at DOME 4.0 1st Hackathon (see Appendix B), except for the lower importance given to extra development needs (understandable as the audience there included proportionally more developers, cf. footnotes).

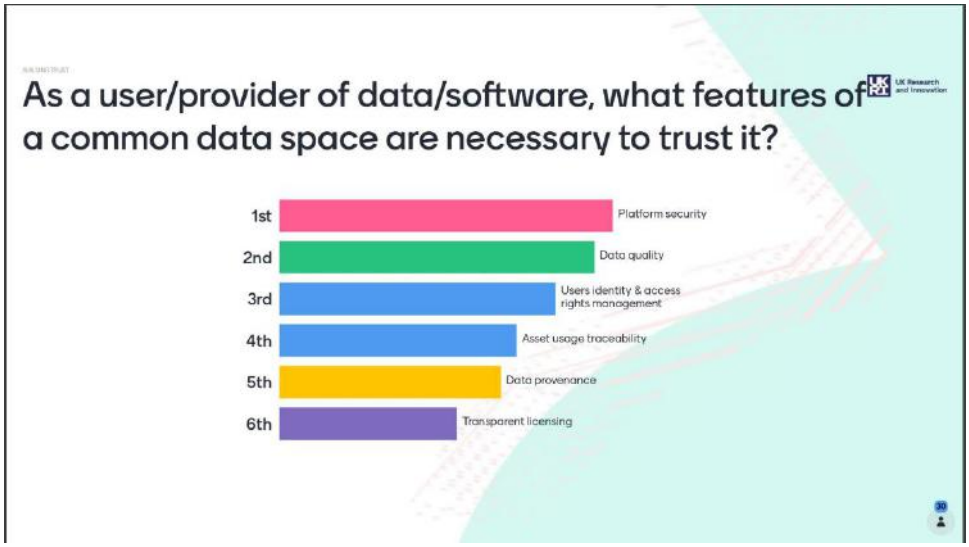

Figure 4 - Snapshot from the Berlin Mentimeter presentation, day 1, results for question Q7

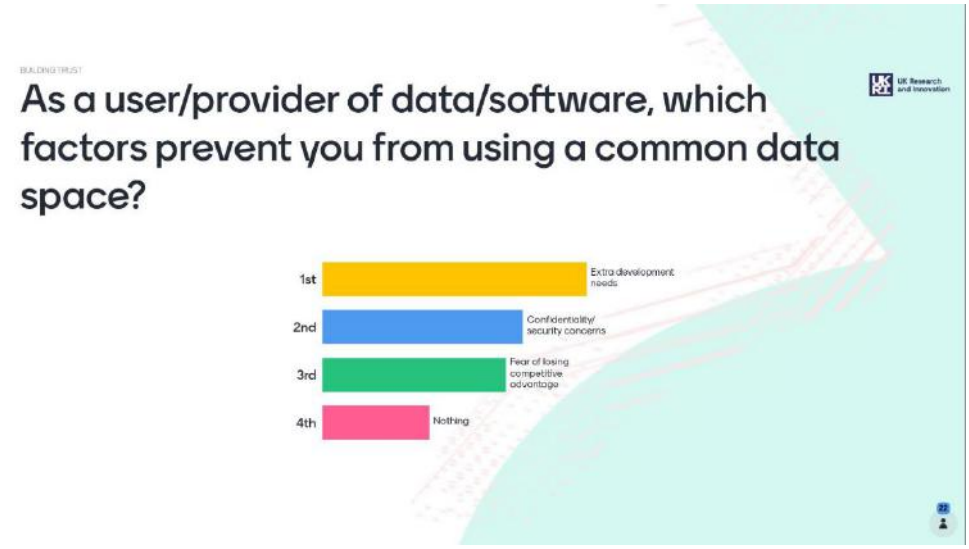

Figure 5 - Snapshot from the Berlin Mentimeter presentation, day 1, results for question Q9

Below we summarize the main points of participants' views about needs, barriers and next steps for the establishment of a MM common data space:

- **Needs/necessary features**
  - Platform security and data quality ranked highest among the necessary features
  - Usability, traceability (of data & usage), transparency (of governance), rights to undo/withdraw
  - Clear added value for both user and provider

- **Barriers**
  - Extra development needs and confidentiality/security concerns ranked highest among preventing factors
  - Complexity, lack of skills and knowledge
  - Sustainable business model (TRL5-7 is still not TRL9)

- **Next steps**
  - Involve/create partnerships with: scientific societies, adjacent disciplines, large companies
  - Develop tools, documentation and training
  - Move closer to industry and applications
  - Sustainable funding models

3.4. Other newly identified difficulties and suggestions

Caveat/Difficulties

- There is a lack of vocabularies/metadata/schema that can be readily used by data creators/owners to improve FAIRness (in particular, the "I"). That is reflected in the answers to the survey during the Berlin workshop (low FAIRness currently). It has also been recognised as a result of OntoCommons work on analysing materials terminologies and domain ontologies in WP3 and has led to collaboration within RDA to set up a WG on *"Harmonised terminologies and schemas for FAIR data in materials science and related domains".*
- Matching data provider and data user different perspectives[28]: a small-scale experiment showed nicely how the metadata / information that data providers give is not always what data users actually need. (Related topics: annotation, discoverability, match-making). This issue was pointed out for materials data, but can be generalized broadly.
- When building a platform, it is hard to find the right building blocks: opting for commercial solutions ensures a state-of-the-art level, however brings constraints on the licensing type of the additional developments. On the other hand, free and open-source components might lack support and updated documentation.

Suggestions/recommendations and future steps to support collaboration

- The field requires a concerted effort on metadata/schema/ontology resources for data producers to annotate their data and increase FAIRness (in particular interoperability). The OCES laid the groundwork and provides recommendations which however still need wide implementation and further investment.
- Need for (data) providers to interact with perspective users. To enable usability and sustainability, co-development and taking into account users' feedback is crucial.

[28] See Talk by Jörg Hohe (Fraunhofer IWM) and Natalja Schafet (BOSCH) at DOME 4.0 2nd Hackathon, Leuven (Belgium), 12th October 2023.

- Support the creation of interoperable and reusable building blocks (in the spirit of DSSC developments). Also, ensure long-term preservation of innovation (beyond project lifetime) of project results.

4. Conclusions

During the second half of the OntoCommons project timespan a set of events have been organized to ensure a two-way communication with the digital marketplaces, culminating in particular with a dedicated three-days focused workshop in April 2023 in Berlin. There, the key enablers for a future materials commons data space, namely FAIR, ontologies and data spaces have been discussed by a varied audience.

Thanks to all these events and to the presence of common beneficiaries, OntoCommons developments have been communicated to the digital marketplace projects, and will especially live on and be further implemented within DOME 4.0, the sibling open-innovation projects and cooperation tasks under umbrella organizations, as the EMMC.

Finally, we recall that this document complements its predecessor (D1.12) and is in turn accompanied by a report dedicated to the Berlin event, to appear on Zenodo in these days.

Acknowledgements

We warmly thank all participants of the events for their contributions to discussions and surveys. And the colleagues from sibling projects, especially DOME 4.0, VIMMP and MarketPlace, for their support.

A. Appendix: OntoCommons FW1.2 - Towards Materials and Manufacturing Commons

A.1. Workshop structure, goal and outcome in brief

Title: *"Towards Materials and Manufacturing Commons - the enablers Digital Marketplaces, FAIR Principles and Ontologies"*

In brief: a hybrid, very interactive event (Berlin, Germany + on-line), 4-6 April 2023

Main organizers: Joana Francisco Morgado, Monika Gall, and Dirk Helm, Fraunhofer Institute for Mechanics of Materials IWM, Freiburg, Germany

Co-organizers: Yann le Franc and María Poveda, Support from colleagues from OntoCommons and beyond

Website: https://ontocommons.eu/news-events/events/towards-materials-and-manufacturing-commons-enablers-digital-marketplaces-fair

Recordings & slides: recordings are available on YouTube (Specific playlist at: https://www.youtube.com/watch?v=KrnbAqioIOs&list=PL-cwgiwYXckMVegcUtTIp7QbAXNvffx_c and the project channel: https://www.youtube.com/@ontocommonsproject1052), and slides of the presentations are available on the event website

Structure: Talks, interactive sessions, round-table discussions

Key topics: Digital marketplaces and data spaces, Materials & Manufacturing Commons, FAIR principles, Ontologies

Participation: 95 registered from 20 countries, 78 organizations (32 attendees in person, 63 attendees on-line)

Goals: Discuss the enablers for data sharing and interoperability in the Materials and Manufacturing domains

Target / Audience: both academia and industry (including ontologists, developers, domain experts, industrial stakeholders)

Outcome:

- Experiences and lessons learnt of digital marketplaces projects in materials modelling and manufacturing (VIMMP, MarketPlace and DOME 4.0)
- Overview of multiple initiatives around FAIR principles and their implementation
- Discussions on ongoing work (AMI 2030), needs, barriers and next steps for a future "Materials Commons"
- Opinions and ideas about semantic technology and ontologies uptake, building trust, sustainable business models
- Example of use cases (talks and posters)

A.2. Workshop agenda: sessions and their aim

Workshop Day 1 – April 4, 2023: Towards implementations of Materials and Manufacturing Commons

Session 1: Key elements of Materials and Manufacturing Commons

Welcome session introducing the topics to be discussed during the workshop namely the OntoCommons project, digital marketplaces, FAIR principles and Materials and Manufacturing Commons.

Session 2: Towards implementation of Materials and Manufacturing Commons: Digital Marketplaces

Session dedicated to the digital marketplaces aiming at sharing experiences concerning the use of semantic technologies and implementation of interoperability.

Session 3: Towards implementation of Materials and Manufacturing Commons: OntoCommons

This session provides an overview through the OntoCommons EcoSystem (OCES) toolkit including it demonstration within pertinent use cases. The translation services advocated by EMMC and addressed in OntoCommons project are also presented followed by a panel discussion on the adoption of FAIR principles and ontologies within the marketplaces to enable Materials and Manufacturing Commons.

Session 4: Towards implementation of Materials and Manufacturing Commons: Data Spaces

The Data Space concept and contribution to the realization of a Materials and Manufacturing Commons is addressed in this session. Different Data Space implementations and related projects are presented in the context of the Materials and Manufacturing domain.

Session 5: Towards implementations of Materials and Manufacturing Commons: Combining views on Materials Commons

Envisioned by the EC and BEDA, this session aims at introducing the Materials Commons ambition embracing a pluralistic view from design to manufacturing. Industrial and academic perspectives on the Materials Commons concept will be given by both industry and research representatives.

1st Interactive Session: Towards implementation of Materials and Manufacturing Commons

The last session of day1 of workshop is rounded up with an interactive session aiming at collecting input from the community to the OntoCommons and EC Roadmap.

Evening Networking and Poster

The 1st day of the workshop concludes with a poster and networking session aiming at discussing in a more interactive manner the Materials and Manufacturing Commons ambition as well as share pertinent research results.

Workshop Day 2 – April 5, 2023: Day 2: FAIR Principles for Industry

Session 1: Introduction to FAIR and example of implementation in Industry

This session addresses the adoption of FAIR principles in industry. In this context, key industry representatives present their current experience and future perspective.

Session 2: Examples from OntoCommons

This session demonstrates the adoption of FAIR principles in the context of OntoCommons use cases. Two OntoCommons demonstrators are presented.

Session 3: FAIR principles in OntoCommons

Different approaches to access compliance with FAIR principles, investigated within the OntoCommons project, are presented in this session. A practical demonstration of these tools followed by Q&A will be given in Day 3.

Session 4: FAIR Resources for Industry: what is happening in EOSC?

In this session FAIR resources for Industry offered by the European Open Science Cloud EOSC are introduced.

Session 5: FAIR Resources from GO FAIR

In this session FAIR resources from GO FAIR are introduced.

Workshop Day 3 – April 6, 2023: Day 3: Materials and Manufacturing Commons for Industry

Session 1: OntoCommons Roadmap collecting Industry needs

This session addressed in more detail the OntoCommons Roadmap by presenting its current status and ambition, collecting additional feedback from the community and enabling participants to pitch their use cases, challenges and vision on the Materials and Manufacturing Commons.

Session 2: Demos

This session aims at demonstrating some of the approaches described during the first two days of workshop namely, the OntoCommons EcoSystem (OCES) toolkit, digital marketplaces and FAIR assessment tools.

Session 3: Hands-on/ Q&A

The workshop ends with an interactive hands-on and Q&A session that gives all participants the opportunity to interact and test the tools presented in the demonstration session and raise any

questions pertinent to the technologies and topics addressed during the 2,5 days workshop. The interactive sessions will be divided by topic to improve the effectiveness of the discussions.

B. Appendix: Extract from DOME 4.0 1st Hackathon, interactive session

In this section we provide an extract of the answers given by the event participants of DOME 4.0 1st Hackathon (Bologna, January 2023) on the topic of digital marketplaces. Please note that a full report of the event will be available next year by DOME 4.0 (cf. footnote in Sec. 2.2). Here we show answers to five selected questions, namely about the **relative importance of data facets**, **and attractive elements / barriers to joining digital marketplaces as seen from both data user and provider perspectives**. About the audience: it included Application developers, Ontologists and Business developers[29], from companies of various sizes where semantic technologies start to be used[30].

When looking for data, the richness/broadness/completeness and quality of data itself were ranked as the most important facets, followed by the availability of documentation and tools. The most attractive facets for users is data/service integration (one-stop shop), whereas for providers the increased visibility / broader audience. Both users and providers agreed in ranking security / confidentiality concerns as the main barrier to joining such platforms.

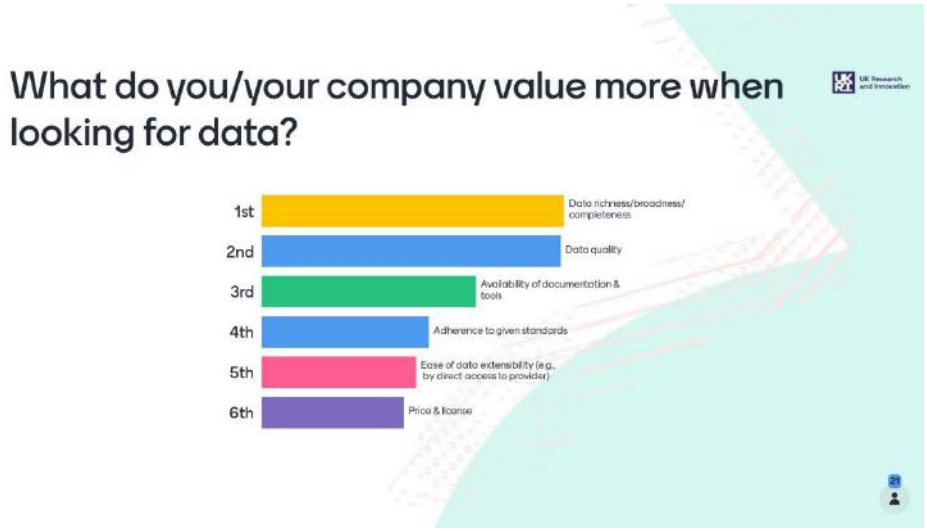

Figure 6 - Snapshot from the Bologna Mentimeter presentation, results for question Q6

[29] In Bologna event, the answers to the question "In which role are you here today?": Ontologist (23%), Database expert (4%), Application developer (36%), End user (0%), Business developer (14%), Other (23%), with a sample of 22 people for this question.

[30] The answers to the question "In your institute/company semantic technologies...", were: "are heavily used (19%), "start to be used (75%), "are not used yet" (6%), from a sample of 16 people for this question.

Figure 7 - Snapshot from the Bologna Mentimeter presentation, results for question Q7

Figure 8 - Snapshot from the Bologna Mentimeter presentation, results for question Q8

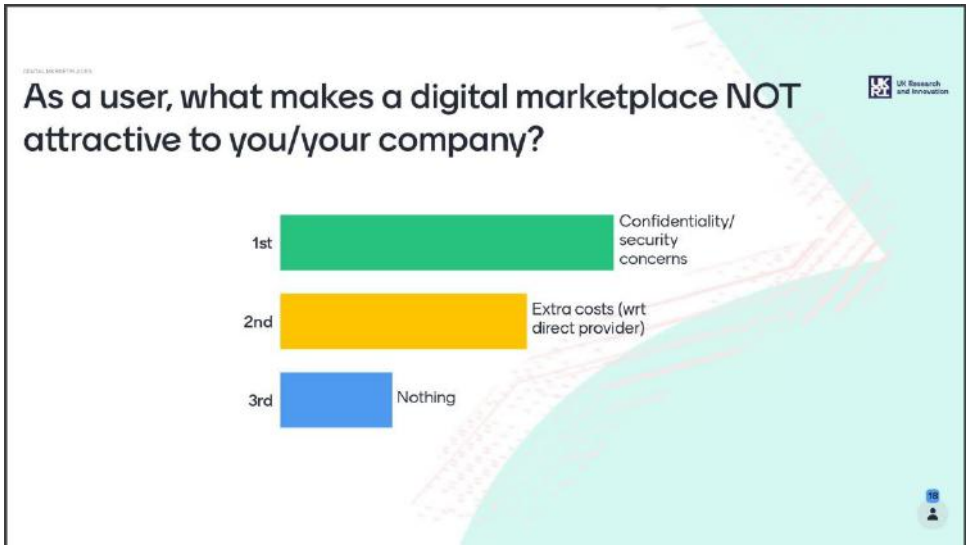

Figure 9 - Snapshot from the Bologna Mentimeter presentation, results for question Q9

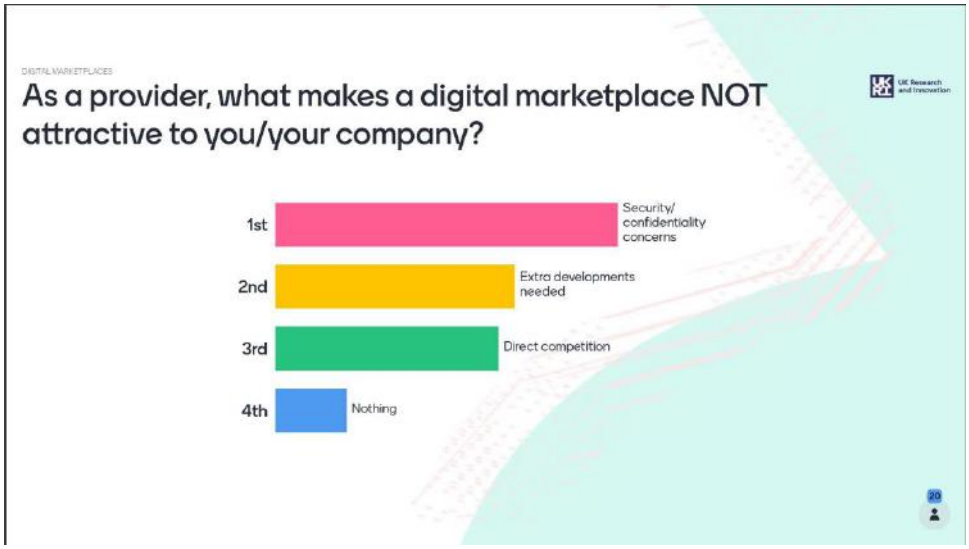

Figure 10 - Snapshot from the Bologna Mentimeter presentation, results for question Q10