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Open Mining Infrastructure for Text & Data

Lessons Learnt -Whitepaper from OpenMinTeD experiences

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Table of Contents

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Acronyms

EOSC	European Open Science Cloud
JSON	JavaScript Object Notation
NIF	NLP Interchange Format
RDF	Resource Description Framework
SAB	Scientific Advisory Board
SME	Small Medium Enterprise
TDM	Text and Data Mining
W3C	World Wide Web Consortium
XML	Extensible Markup Language

Publishable Summary

The goal of this document is to report on the lessons learnt from the OpenMinTeD building infrastructure experience and provide readers a set of recommendations on the way forward.

This document comprises challenges faced over the duration of the project (June 2015 - June 2018) and the experiences gained throughout the project. The experiences are based on the activities that have been described in project milestones and deliverables, on comments and feedback received from the consortium partners and interactions with external actors:

i) The Scientific Advisory Board members, who are experts on TDM, researchers, governance representative, research infrastructures decision makers;

ii) Participants in Open Calls 1 & 2, where users were invited to adapt their resources (i.e. content, and TDM tools and applications), make them compliant with the OpenMinTeD interoperability guidelines and integrate them into the OpenMinTeD platform.

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1. *Introduction*

1.1 Project Background

The OpenMinTeD project is an EC/H2020 funded project (grant agreement 654021). It started in June 2015 with a total duration of 3 years. The consortium comprised 15 partners, representing content providers, scientific communities, text mining experts, infrastructure builders, legal experts, data and computing centers, industrial players, and SMEs.

1.2 Objective

OpenMinTeD set out to:

> Establish an open and sustainable TDM platform and infrastructure where researchers can collaboratively create, discover, share and re-use knowledge from a wide range of text based scientific related sources in a seamless way to advance research, promote interdisciplinary open science, and ultimately support evidence-based decision making.

OpenMinTeD has fulfilled its objective and succeeded in building an infrastructure that fosters and facilitates the use of text and data mining technologies in the scientific publications world and beyond, by both application domain users and text-mining experts. SMEs are also welcome to use the platform's services and showcase the OpenMinTeD value in the industrial world.

1.3 Current Status

OpenMinTeD had laid the solid foundations for an open text and data mining e-infrastructure that will influence and, in some cases, transform the way communities and technologies interact and collaborate. As shown in Figure 1, this is a complex endeavor with increased technological and organizational challenges, as a text and data mining infrastructure requires the synthesis and consensus for an interoperability framework that touches upon different aspects. These are:

- the content to be mined from content aggregators and repositories (e.g. OpenAIRE, CORE, EuropePMC, etc.) and the legal rules that govern it: how to access and reuse content, what actions are permitted, and which are prohibited;
- existing text mining technologies and platforms: what are the most appropriate architectures, how to use existing platforms or a selection of their components, how to configure and combine them with the appropriate ancillary knowledge resources, how to adapt them to new scientific domains;
- text mining applications: how these are viewed and used in different scientific domains; how can we combine tools used in specific domains and broaden their uptake?
- big data technologies and computing infrastructures: how to foresee scaling up to massive content, how to bind to and combine cloud computing as seamlessly as possible in the processes.
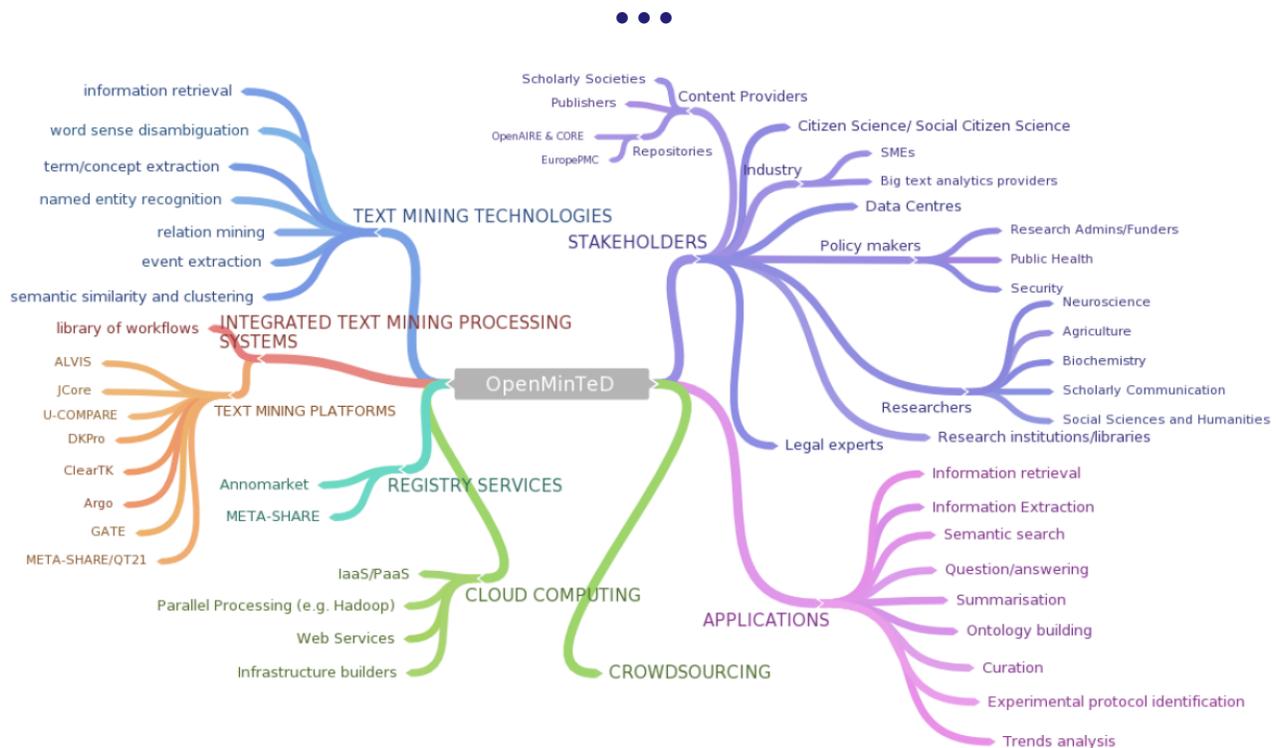
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Figure 1: OpenMinTeD bringing together and bridging gaps between technologies and communities

1.4 Future Status

OpenMinTeD has a central position in the Open Science ecosystem, as it has all the potential to be a "TDM Hub" for scientific literature within the EOSC ecosystem.

Figure 2 specifically illustrates how OpenMinTeD is placed among existing EU infrastructures, providing a gluing mechanism for researchers to access content in a secure way and mine it on the cloud.
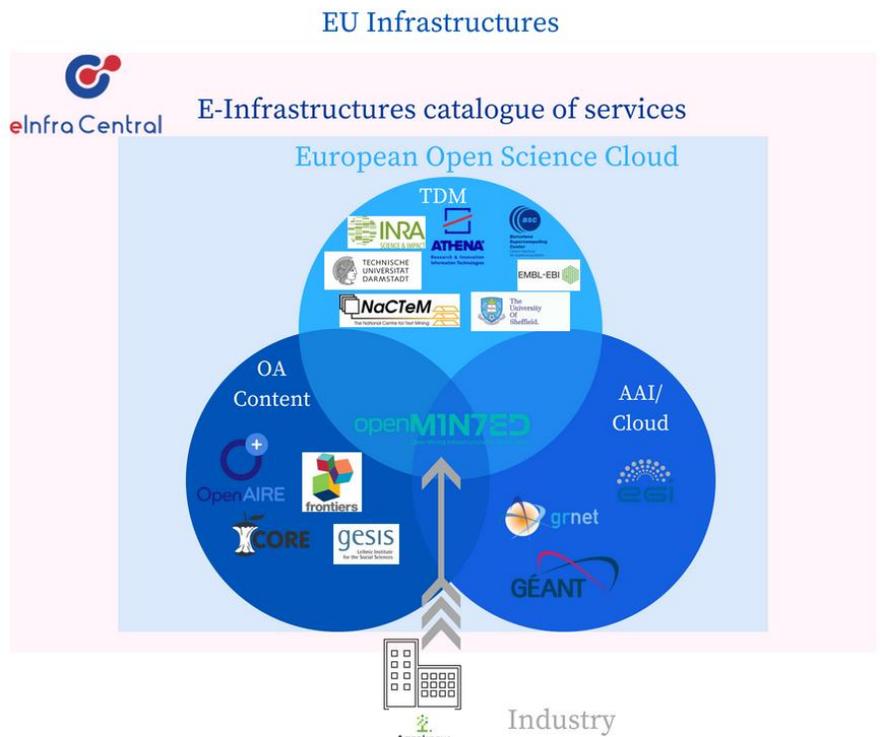

Figure 2: EU Infrastructures and EOSC ecosystem

1.5 Achievements

The main challenges and achievements of OpenMinTeD are to:

Consensually come up with the interoperability framework that will allow existing tools and platforms, as well as resources and content to become an integral part of the text-mining infrastructure. Create a technical platform to guide, showcase and promote the participatory infrastructure to all researchers, curators, content and data providers and text-miners alike.

OpenMinTeD has specified and implemented an interoperability framework to support the registration and integration of content resources and TDM tools and components in the platform, addressing the following aspects:

– **Interoperability** specifications and guidelines[1] were defined following a landscaping report on existing protocols, technologies, and metadata schemas for documenting content, ancillary knowledge resources, and text mining and processing services.
– A study on **copyright restrictions and exceptions and licensing terms** for both textual sources and text-mining services was conducted aiming to address legal interoperability.
– A study on **annotation and workflow services** examined annotation models/type systems, input-output representation formats (e.g., XML, RDF, JSON, NIF, W3C Annotations), appropriate annotation service input-output conversions, type system alignment, annotation tag sets, confidence scores, workflow persistence formats (e.g., UIMA aggregate engine descriptor).

As a result, OpenMinTeD offers a platform with the following key characteristics:

1. An **actionable TDM service/tool catalogue**, offering a variety of options to TDM experts to register different TDM components (e.g., Docker Hub, XML forms, Web services, Maven).
2. **Seamless content connectors** enabling the ingestion and synchronization of OA repository and publishers' data into the OpenMinTeD platform:
    - o non-standard systems of content providers
    - o ingestion of repository research articles
    - o synchronization of datasets between different distributed subsystems of the OpenMinTeD infrastructure
    - o APIs for accessing content hosted on the platform.

Note: The consortium expertise as represented by UNIMAN (Argo, U-Compare), USFD (GATE, AnnoMarket), UKP-TUDA (DKPro), INRA (Alvis), Athena RC (OpenAIRE) and Open University (CORE) has proved invaluable.

Provide all the necessary, participatory design based, support structures for the awareness, proper use and uptake of TDM services by the stakeholder communities, through a wide range of mobilisation, engagement, support, training activities and hands-on exercises.

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[1] https://guidelines.openminted.eu/

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OpenMinTeD promotes awareness of the benefits of TDM, supports the training of text mining users and developers alike and demonstrates the merits of the approach through several use cases identified by scholars and experts from different scientific areas, ranging from life sciences (bioinformatics, biochemistry, etc.) to food and agriculture and social sciences and humanities related literature.

For this purpose, training material, tutorials, courses and webinars are available on the FOSTER[1] platform (Figure 3). The tutorials support the training of a range of stakeholders on how to use the OpenMinTeD platform, how to access and deploy various TDM applications integrated in the platform (from the project use cases and open calls), good practices and background information. Training focuses on four communities on board the project as well as newcomers and other interested parties.

Figure 3: OpenMinTeD tutorials in FOSTER

Explore and recommend business models towards the sustainability of OpenMinTeD, to become a hub for text mining service providers to build innovative services that promote a new culture in open scholarship and open science.

OpenMinTeD is an open and sustainable TDM platform and infrastructure where researchers can collaboratively create, discover, share and re-use knowledge from a wide range of text based scientific

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[1] https://www.fosteropenscience.eu/openminted

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related sources in a seamless way to advance research, promote interdisciplinary open science, and ultimately support evidence-based decision making. A sustainability model study and a sustainability report have been delivered and are available to the consortium and EC members.

2. *Lessons Learnt*

We will examine the lessons learnt from planning to implementation of the project. They are grouped into the following subcategories:

- Technical
- Legal
- Quality & Trust
- Training and support
- Synergies

2.1 Technical

#1 – Modularity of platform. Re-use of open and community supported technologies

Analysis: The OpenMinTeD platform was designed and developed based on existing technologies: the META-SHARE[1] data model, Galaxy workflow engine, the DKPro Annotation Editor and open source tools for the cloud interface (Apache Mesos, Chronos), were all integrated into the OpenMinTeD Registry core module.

Use of **OMTD-SHARE metadata model**, which builds upon META-SHARE schema, which was designed for the description of language resources (e.g. datasets, knowledge resources and processing tools/technologies) and has been used in various projects over the last few years. The adaptation involved restrictions and extensions to accommodate the needs of OpenMinTeD.

The OpenMinTeD workflow execution backend and the workflow editor have been based on **the Galaxy workflow engine and editor** which are used in several similar TDM platforms (e.g. LappsGrid, Alveo). Galaxy is mainly designed to run as a standalone consolidated system and it posed a variety of obstacles which delayed the integration, deployment and efficient performance (e.g., lack of detailed documentation, APIs not rich enough for integration, often obsolete facets, critical bugs/issues).

Impact: We have a modular, flexible and extensible platform in which the core modules can be easily replaced. Appropriate APIs and interfaces have been designed to facilitate modularity; for example, the AERO REST interface was created in the context of the project for accessing/managing an Annotation Editor/Viewer.

Lesson: The use of widely known open source technologies supported by large communities in building our solutions allows us to easily (a) maintain the platform and (b) port it to other data centers and cloud infrastructures.

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[1] www.meta-share.org

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Well-known already used and tested resources, e.g., protocols, schemas, standards, but also tools, that are an appropriate solution for a specific requirement should be modified/extended and re-used. There is no need to reinvent the wheel in such cases.

#2 – Agility and flexibility in the design

Analysis: Technology is rapidly evolving, new algorithms, protocols and standards are emerging, and users change and/or increase their requirements; so, infrastructures need to be able to continuously adjust to the new landscape. The initial user requirements for OpenMinTeD have given rise to the functional requirements of the platform and the overall system architecture. Further technical requirements (e.g. to accommodate Docker images and web services and new interoperability specifications), and feedback from external users, especially from participants of the Open Calls, have created the need for adding functionalities in the platform and changing the metadata schema.

Impact: New requirements have resulted in changes of the metadata schema, the registry and consequently the user interface. This has produced some delays in the workplan (which have been subsequently caught up), but the changes led to the overall improvement of the platform. In general, the design and implementation of the OpenMinTeD platform and its supporting mechanisms (metadata schema and modules) have proven that they can adequately accommodate changes. When major changes were required, alternative solutions have been sought.

Lesson: Responding to new or changing requirements and being able to accommodate new functionalities is a desired feature for infrastructural platforms. Their design must, therefore, include methods and mechanisms for quickly adapting to such needs; otherwise, alternative solutions (e.g. in the form of add-ons), that do not require the redesign and total change of the platform, must be sought.

#3 – Open Science to bootstrap TDM value

Analysis: TDM processing involves various kinds of resources, i.e. content, software and ancillary resources, all coming from different sources. Moreover, TDM software may result from the synthesis of tools performing basic processing tasks, again coming from different sources. The combination of all these resources together involves technical as well as legal barriers. In OpenMinTeD we have decided to integrate in the platform Open Access (OA) scholarly content and FOSS software. This has allowed us to separate legal from technical issues, study legal interoperability in an offline mode (WG3) and focus on technical interoperability in the platform (WG4 in collaboration with WG1 and WG2). The participation in the consortium of experts from the most prominent technical communities (UIMA, GATE) and discussions among them has resulted in a generic framework.

Impact: Users can use different TDM applications built with different tools and technologies, combine them when this is allowed, analyse big datasets of open access content and get results; all in one platform.

Lesson: OpenMinTeD has succeeded in offering end-user ready-to-use TDM applications that can be used to process open access content and, thus, show the value of integrating TDM technology in research workflows. This has been accomplished because the use of Open Access content and FOSS has alleviated the respective legal obstacles and allowed us to focus on technical issues.

#4 – Inclusiveness and infrastructure coverage

Analysis: An all-inclusive TDM infrastructure requires a holistic approach which includes people, skills and technology.

Impact: OpenMinTeD has made a first step in connecting people with different skills (open science, TDM experts, communities) into collectively share knowledge and come up with sustainable solutions. Even though this needs to be reinforced in the future, we have illustrated the practicality and effectiveness of the holistic set up.

Lesson: An All processes need to be in place: infrastructure, TDM tools, content, TDM workflows, people, training, and must be brought together as early on as possible, at the design phase.

2.2 Quality & Trust

#5 – Quality of service. Evaluation of platform and processes

Analysis: The quality of OpenMinTeD content and services is important as it is a key point for its uptake. There is a positive relationship between service quality and trust, trust and users' loyalty and value. The OpenMinTeD infrastructure has been evaluated through a well-defined procedure based on the usage of the platform by (a) the consortium partners for building and integrating the domain specific applications, and (b) the winners of the open calls for integrating their content and software. The evaluation indicators recorded performance, quality and usability. The evaluation framework comprised various tools (evaluation checklists, questionnaires, evaluation form). The issues that were investigated were:

- TDM related; e.g., registering and running a text mining component or workflow
- ease of use of the platform services (registry, workflow editor, annotations viewer, corpus builder, applications execution, support) by service/content providers
- ease of service/content registration, service/content discoverability and integration of services and content in workflows, etc.
- response time and quality of the technical support
- user experience
- learning opportunity from the overall experience
- sufficient and clear documentation supporting the use of the platform (e.g. guidelines, interoperability specifications, examples, etc.)

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Impact: The evaluation process has contributed to the overall improvement of the platform. For instance, winners of open calls initiated a process of raising issues, posing questions, and discussions about the platform. Last, guidelines, tutorials and training material were further improved through their comments.

Lesson: A complex infrastructure like OpenMinTeD needs a continuous and iterative evaluation and validation process. Including an evaluation procedure with a well-defined methodology at an interim phase of the implementation lifecycle and involving external users in this process is important for receiving feedback on the assets and drawbacks; this feedback can influence positively the design of the platform.

#6 – Security and privacy

Analysis: The OpenMinTeD infrastructure bridges content (often uploaded by users in their private space) with actionable services, utilizing cloud computing resources (which do not come for free). Moreover, content to be mined or resulting content may have privacy issues, needing to abide to GDPR at the least. This calls for stricter measures to ensure a secure system service and operations. AAI (Authentication & Authorization Infrastructure) and accounting are key services to include in the public release. In addition, the definition of roles (who has access to what, who is able to process what) must be defined and aligned with other digital infrastructures.

Impact: Security and privacy are fundamental factors for the uptake of a trusted infrastructure.

Lesson: Security and privacy must be embedded by design and planned and deployed from the early stages. Extra effort on an effective AAI design, security testing (e.g. penetration testing, etc.) and operational support must be further accounted for. Furthermore, in order to successfully embed OpenMinTeD and TDM in the EOSC ecosystem, we need to ensure bridges to state of the art EU/EOSC AAI and security developments.

#7 – Access policies, rules and principles of participation

Analysis: OpenMinTeD is a technically demanding endeavor, involving different actors, resource types and influenced by internal and external factors. When setting up the platform and the infrastructure components, an initial set of decisions, methods, policies and strategies was made as to the technical and other aspects of the project. During the project life time there has been a need to adapt to new conditions and re-work approaches and strategies at a number of levels. For instance, technical specifications have been re-adjusted to consider emerging technical solutions (e.g. specifications for TDM web services and for Docker components). Each change affected different aspects and several documents, e.g. policies, FAQ's, guidelines, technical documentation, etc., which made necessary the use of online collaborative editing/publishing systems for the documentation (e.g. GitHub, GitBook, Google Docs).

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Impact: Being open and flexible to new situations has allowed us to quickly adjust our strategies. The use of online collaborative tools made it easier and less time-consuming to keep up-to-date documentation to changes.

Lesson: A plan needs to be setup from early stages for the various aspects (technical, legal, policy). The plan needs to be well balanced between achieving a stable ground that leads to a solid implementation and remaining open and flexible to allow for minor adjustments to new or changing situations; the plan needs to be re-visited at regular intervals and re-adjusted as needed. Selecting online tools is helpful for quick updates of the documentation.

2.3 Legal

#8 – Legal Fuzziness

Analysis: One of the most important barriers in TDM is the dubious legal status of the content to be mined. Content providers and distributors (publishers, journals, infrastructural and institutional repositories, etc.) tend to be agnostic or seemingly indifferent to stating access rights and rights of use; the use of classification categories (e.g. embargo, closed/open access, rights reserved, free/paid access, etc.) does not suffice for all uses. Attaching a licence (especially a standard one) to a resource and indicating what this licence is in its description (e.g. by stating the licence name or linking to a URL with the legal text) is crucial to its further use. Even though the situation has improved with the TDM exception in the EU copyright legislation, the framework is still fuzzy as there is no harmonization at the level of all EU countries. Most of the content imported in OpenMinTeD is stamped as "Open Access" but with no licence attached to it; this creates doubts as to the access conditions for the output of TDM processes.

Impact: The lack of a clear licence attached to the content to be mined creates doubts for the legal status of the TDM output which creates a bottleneck to the TDM process. This has forced us to block the downloading of original resources not clearly marked with a licence, as well as of their annotated outputs (when they contain the original text), until the legal framework is made clearer.

Lesson: Legal awareness must be sought at all times and costs and from the very beginning of any project that purports to distribute assets. OpenMinTeD has taken several actions to improve the situation, including raising awareness among content providers and creators, promoting the application of standard licences, lobbying for the TDM exception and Open Access policies. This is also prominent at the support page of the OpenMinTeD website. Even though legal issues have been one of the high priorities in the agenda of OpenMinTeD, the achievements are important but do not provide a definite solution; and this is understandable since the main factors for the success are external to the project; this should not be underestimated and alternative ways of dealing with resources of fuzzy legal status must be foreseen.

#9 – Clarity of copyright issues

Analysis: Legal clarity is a major issue that was recognised since the beginning of the project. As a result, the most critical task in the project was the recording, support and monitoring of the legal interoperability working group. OpenMinTeD has explored the potential reform of copyright and database right laws relating to Text and Data Mining. The scope being the provision of text mining platforms for mining scientific publications, these exceptions will consider the needs of both providers and users of corpora and related technologies and services and will aid the seamless sharing and distribution of resources for text and data mining, based on a system of standard licences and proposed terms of service.

Impact: The legal perspective on TDM has been examined in terms of content, software and services by the legal experts, who have drawn the OpenMinTeD Compatibility Matrix that can be further disseminated and used by other RIs.

Lesson: During the project duration, the legal perspective on TDM was examined in terms of content, software and services. All the above resulted to a magnificent OMTD compatibility matrix that can be further disseminated and used by other RIs.

2.4 Dissemination, Training and Support

#10 – User Interface, Support and training material

Analysis: One of the goals of OpenMinTeD was to create a platform where researchers with little or no technical background and knowledge of TDM algorithms can easily find and run TDM applications on the content of their choice. This was achieved and accompanied by several training and support material (guidelines, tutorials) meant to assist end users. The UI/UX of such a complex, multi-faceted and multi-user-targeted system requires a more sophisticated and iterative approach, with active end user engagement. The OpenMinTeD project communities provided a first feedback, and the winners of the open calls a second pass, but further work is still required.

Impact: A user friendly TDM platform along with training material are crucial for TDM to be an integral part of the open science and research ecosystem.

Lesson: End user UI/UX friendliness is often underestimated. OpenMinTeD will need to further improve its user interface and user experience via active user engagement (formation of a formal user group), and also give emphasis in the production of support and training material to facilitate a lower entry barrier, for all groups of users.

#11 – Exploitation of opportunities for dissemination and collaboration.

Analysis: Communication channels of all partners and TDM software communities have not been fully exploited, as the official launch of the platform was towards the end of the project.

Impact: Establish an active network for collaboration, reaching out to TDM experts for interoperability guidelines, for architectural components (e.g. Galaxy community, Lapps), for linking to EOSC (e.g., EOSC-hub, OpenAIRE, Geant).

Lesson: The task of establishing collaboration links with communities working on the same or similar projects must be further promoted and included in future workplans.

#12 – Engagement and involvement of external users and experts

Analysis: The OpenMinTeD platform was tested by internal users while being built. However, the real test for the platform and its supporting resources (guidelines, technical instructions, etc.) was its use by external users. Winners of the Open calls who registered their tools in the OpenMinTeD platform provided a good feedback on the platform and the guidelines as they provided the outside perspective on services and procedures that internally were considered a clear and step forward process. Technical assistance with detailed guidelines, and continuous support proved indispensable for the platform users. Open Calls challenged and tested the platform operations (non-tech) also, as outsiders were asking on glossary terms, processes, and the knowledge base.

Impact: The feedback received from external users has led to the improvement of the processes, the relevant guidelines and documentation, as well as of the interoperability specifications.

Lesson: Similar to the UI/UX context, it is important to involve external users in a continuous and iterative testing and advising process, a formal user group engaging different types of users, representing all facets of the complex OpenMinTeD infrastructure.

2.5 Synergies

#13 – Collaborations with other EU projects, RIs and organizations

Analysis: OpenMinTeD is a gluing e-Infrastructure for TDM and should disseminate and promote its quality services in the EU and globally, a process which requires extensive user engagement and awareness among various scientific domains and multiple stakeholders (content providers, software providers, funders, governments, organizations, SMEs, researchers, libraries, universities, etc.). Its central position called for the establishment of collaborations between OpenMinTeD and other projects, RIs and e-Infrastructures: OpenAIRE, CORE and CrossRef for linking to content; CLARIN and Elixir for most relative research infrastructures involved in TDM; EGI, EUDAT for e-Infrastructure service provision (cloud computing, storage, repository, AAI); e-InfraCentral for registering OpenMinTeD services in the emerging EOSC service catalogue.

Impact: OpenMinTeD has been aligned with the EU (research) policy initiatives in general. Improving the awareness of users and stakeholders towards its assets can expand TDM for data science. As long as

OpenMinTeD services are listed/promoted within EOSC (via the eInfraCnetral service catalogue), its role in the EU open science ecosystem as a TDM hub will be of key importance.

Lesson: OpenMinTeD's openness for cooperation with other RIs and E-Infrastructures in EU exposed its services to a broader audience, increasing TDM visibility and impact. This collaboration can be further improved, tried, benchmarked, and evaluated. Its presence in the eInfraCentral service catalogue (EOSC), is expected to further improve the services (and their provisioning) as they will be presented to a broader audience and can be compared with services of other RIs.

#14 – Local & Cloud installation

Analysis: The OpenMinTeD platform was originally designed to be deployed and run in a cloud infrastructure as well as at local installations. This dual deployment was meant to increase the benefits for end-users: the cloud infrastructure offers scalability, increased computing power and no installation and the latter option was meant to overcome any legal barriers to mine specific content or fit specific operational (hardware) requirements of the mining tools.

Impact: Meet different end-user requirements and overcome legal and technical obstacles. OpenMinTeD is able to broaden its operations and uptake by allowing both types of deployment.

Lesson: A distributed set of installations, supported and operated by local organizations, build a community of practice around TDM, broaden the data and open science, and effectively increase the uptake of the OpenMinTeD platform. Different deployment options require further, and different king of resources.

#15 – Opening Up to external key players

Challenge: Opening-up to external experts that are key players in the TDM and Open Science ecosystem.

Analysis: During the project's duration, two scientific advisory boards were organized. The members of the board were all active and experienced on TDM, or Open Science, as well as Governance structures. The feedback and advices provided assisted on forming a better interoperability layer, define a glossary, improve services and uptake.

Impact: OpenMinTeD was already known and monitored by external experts even before its completion. These experts represent important RIs in Europe and abroad. As such, there is more room for synergies with the organizations these experts represent, as the people who were involved already have a connection with OpenMinTeD. There were part of the process and OpenMinTeD is familiar.

Lesson: Involvement of key external players of the ecosystem helped OpenMinTeD with advices on how to proceed and be on the map of other RIs that would be willing to form a synergy taking advance of the OpenMinTeD services.

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3. *Summary*

Lessons learnt prove that there are successes, reconsiderations and potential, for future, improvements on all sessions mentioned; technical, legal, quality and trust, training, synergies.

OpenMinTeD on its core principle, does not operate in isolation. This is something that needs to be continued and promoted as a strategy on all aspects; cooperation, openness, exploitation and fitting in the whole EU RIs ecosystem and EOSC. Until OpenMinTeD gets more mature, more lessons will be learnt.