National Technical University of Athens

TUS

IMGGI

UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

D1.2 Data Management Plan (DMP)

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or EIC. Neither the European Union nor the granting authority can be held responsible for them.

Funded by the European Union

Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

National Technical University of Athens

TUS

IMGGI IMGGE

UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

Grant Agreement No.	101159570
Project acronym	**TwInn4MicroUp**
Project name	Twinning Innovation Hub for Microbial Platforms in Plastic Upcycling
Start Date/Duration	September 2024 /36 Months
Call	HORIZON-WIDERA-2023-ACCESS-02
Type of Action	HORIZON-CSA
Deliverable No. & Title	**D1.2 Data Management Plan (DMP)**
Due month	February 2025 (M6)
Responsible Partner	NTUS
Delivery month	M6

Type of Document (Dissemination Level)	
Public	X
Sensitive	
EU Classified	

History of Changes		
VERSION	DATE	DESCRIPTION
v1.0	28/02/2025	DMP First Version

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Document Control			
VERSION	DATE	AUTHOR	ORGANISATION
v0.1	10/09/2024	Jasmina Nikodinovic-Runic	IMGGE
v0.2	17/09/2024	Efstratios Nikolaivits	NTUA
v0.3	07/02/2025	Christina Ferousi	NTUA
v0.4	08/02/2025	Evangelos Topakas	NTUA
v0.5	20/02/2025	Gennaro Agrimi	UINBA
v0.6	24/02/2025	Jasmina Nikodinovic-Runic	IMGGE
v0.7	24/02/2025	Marija Nicevic	TUS
v0.8	24/02/2025	Christina Ferousi	NTUA
v0.8	26/02/2025	Evangelos Topakas	NTUA
v1.0	27/02/2025	**Approval by all participants**	

Partners

NTUA: Ethnicon Metsovion Polytechnion (National Technical University of Athens)

TUS: Technological University of the Shannon: Midlands Midwest

IMGGE: Institute of Molecular Genetics and Genetic Engineering, University of Belgrade

UNIBA: Università Degli Studi Di Bari Aldo Moro

Abbreviation List

Advanced Encryption Standard: AES, 28
Agreement Maker Light: AML, 20
Author Accepted Manuscript: AAM, 25
CC Public Domain Dedication: CC0, 18
Consortium Agreement: CA, 6
Core Scientific Metadata Model: CSMD, 40
Creative Commons: CC, 18
Crystallographic Information Framework: CIF, 40
Data Management Plan: DMP, 6
Digital Object Identifier: DOI, 15
European Open Science Cloud: EOSC, 36
European Publication Server: EPO, 11
File Transfer Protocol: FTP, 18
General Assembly: GNA, 7
General Data Protection Regulation: GDPR, 28
Google Drive: GD, 28
Grant Agreement: GA, 6
Horizon Europe: HE, 6
Hypertext Transfer Protocol: HTTP, 17
Hypertext Transfer Protocol Secure: HTTPS, 28
Intellectual Property: IP, 11
Intellectual Property Rights And Exploitation Board: IPREB, 12
International Union Of Crystallography: IUCR, 38
Investigation/Study/Assay: ISA, 38
Macromolecular Crystallographic Information Framework: MMCIF, 38
Minimum Information For Biological And Biomedical Investigations: MIBBI, 39
Non-Disclosure Agreement: NDA, 18
Objectives: O, 9
Open Access: OA, 6
Open Archives Initiative Protocol For Metadata Harvesting: OAI-PMH, 15

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

PDB Exchange Dictionary: PDBx, 38
Persistent Identifier: PID, 15
Plastics-Active Enzymes Database: PAZy, 36
Protein Data Bank: PDB, 38
Recommended Metadata For Biological Images: REMBI, 39
Resource Description Framework: RDF, 20
Tab-Delimited: TAB, 38
Transport Layer Security: TIS, 28
Version Of Record: VoR, 25
Work Package: WP, 6
Worldwide Pdb: wwPDB, 38

List of Tables

Table 1. Selected data sources and repositories. 9
Table 2. Expected types and formats of TwInn4MicroUp data outputs. 12
Table 3. Research outputs sharing approach. 23
Table 4. Data management responsibilities within the TwInn4MicroUp project. 26
Table 5. Data storage and security procedures (NTUA). 28
Table 6. Data storage and security procedures (TUS). 28
Table 7. Data sharing and data security procedures (IMGGE). 28
Table 8. Data sharing and data security procedures (UNIBA). 28

Table of Contents

PARTNERS 3
ABBREVIATION LIST 3
LIST OF TABLES 4
1. EXECUTIVE SUMMARY 6
2. PROJECT OVERVIEW 8
3. DATA SUMMARY 8
4. FAIR DATA 14
4.1. MAKING DATA FINDABLE, INCLUDING PROVISIONS FOR METADATA 14
4.2. MAKING DATA ACCESSIBLE 16
4.3. MAKING DATA INTEROPERABLE 18
4.4. INCREASE DATA RE-USE 20
5. OTHER RESEARCH OUTPUTS 22
6. ALLOCATION OF RESOURCES 25

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

7. DATA SECURITY 26

8. ETHICS 27

9. OTHER ISSUES 28

10. BIBLIOGRAPHY 29

ANNEXES 31

ANNEX I – GENERATED DATASETS 31

ANNEX II – FAIR CHECKLIST 32

ANNEX III –REPOSITORIES AND DATABASES 34

ANNEX IV – DISCIPLINARY METADATA STANDARDS 36

ANNEX V – "README" FILE TEMPLATE FOR METADATA 40

ANNEX VI – DATA AVAILABILITY STATEMENT EXAMPLES 43

ANNEX VII –SCIENTIFIC PUBLICATIONS LIST 44

ANNEX VIII –DATA MANAGEMENT BODIES 45

Funded by the European Union

Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

1. Executive Summary

The present document is the first version of the TwInn4MicroUp data management plan (DMP) and fulfils the requirements for the deliverable D1.2 Data Management Plan. The TwInn4MicroUp DMP will be revised throughout the entire project duration and updated in the upcoming Deliverable D1.3 (DMP updated– M17).

The TwInn4MicroUp project will address all seven stages of the data lifecycle—Plan, Collect, Assure, Describe, Preserve, Integrate, and Analyse—detailing the processes for managing data from its creation through to its preservation and eventual use. The present DMP is an indicative plan as to what kind of data the project beneficiaries expect to generate during the project, and how these data will be managed. It outlines the strategies and procedures for handling, storing, and sharing data generated during the project, ensuring compliance with relevant regulations and promoting data integrity and accessibility. In preparing the DMP, we adhered to the provisions of the Grant Agreement (GA) and the Consortium Agreement (CA) concerning open science, responsible research data management principles, and new approaches to open access for scientific publications and other research outputs. This DMP also incorporates the recommended open science practices encouraged by the Horizon Europe (HE) program, while respecting the specific requirements of this HORIZON WIDERA project and its innovative aspects. The development and updating of the DMP are managed within work package (WP) 1, led by NTUA, with active participation from all consortium members. This collaborative effort will continue for future updates, encompassing not only the provision of individual information in the tables and annexes but also the definition of procedures and approaches for responsible research data management.

The DMP is structured in full accordance with the recommended European Research Council template[1], using all relevant HE guides, as well as recommendations from established organizations and working groups (**Section 10**) for the purposes of research data management and open access (OA) practises. For the implementation of the DMP in the collaborative and innovative TwInn4MicroUp project, effective and sustainable procedures for continuous and responsible data management were deemed necessary, thus several annexes of this DMP are designed for the ongoing input of data and information throughout the project. Consequently, this DMP serves both

[1] Data management plan (HE): V1.1 – 01.04.2022

as an implementation guide for research data management—with some annexes providing guides and auxiliary tools for TwInn4MicroUp researchers— and as a crucial monitoring tool for the general assembly (GNA) and all consortium members. This approach to data management will facilitate easier reporting on the project's data management aspects and aid in completing the final version of the DMP (Deliverable D1.3: DMP updated– M17).

The list of annexes includes:

- **Annex I** – Generated datasets, to be continuously updated
- **Annex II** – FAIR Check list
- **Annex III** – Recommended and selected repositories and databases (currently stating the recommended; to be updated with the list of selected trusted repositories and databases in future versions of the DMP)
- **Annex IV** – Disciplinary metadata standards relevant for the TwInn4MicroUp project
- **Annex V** – "Readme" File Template for Metadata
- **Annex VI** – Data availability statement examples
- **Annex VII** – List of scientific publications, to be continuously updated
- **Annex VIII** – Responsible people for TwInn4MicroUp data management (to be updated should any change of nominated responsible people occurs)

Section 3 provides a summary of the data to be collected and generated during the project, including their types, formats, approximate scope, and potential sources of secondary data from open repositories and databases. Section 4 details the application of the FAIR principles for data handling. Special attention is given to managing other research outputs, such as workflows and samples, in line with the FAIR principles (Section 5). Implementing open science practices requires human, financial, and material resources, outlined in Section 6. Data security and ethical principles are covered in Section 7 and Section 8, respectively. Section 9 offers an overview of relevant procedures related to data management at various levels. This DMP is part of the overall project management strategy for TwInn4MicroUp, regulating the management of all research outputs throughout the research cycle and beyond, ensuring safe, long-term preservation and wide visibility.

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

2. Project Overview

TwInn4MicroUp is a three-year project funded by the EU Horizon Europe HORIZON-WIDERA-2023-ACCESS-02, which started in September 2024. It involves four partners of which three from EU countries (Greece, Ireland and Italy) and one Associated Country (Serbia), all research institutions. The primary objective of the TwInn4MicroUp project is to significantly enhance the competitiveness and capabilities of NTUA in the areas of Project Management and Administration, Budget Acquisition, and Synthetic Microbial Biotechnology research. This enhancement aims to elevate NTUA's research profile, contributing to the advancement of European socioeconomic goals. TwInn4MicroUp aims to introduce an innovative approach to upcycling plastic waste by utilizing green biological/mechanical/chemical technologies to recover plastic monomers. This project will leverage modern molecular techniques to develop microbial cell factories that can produce bioactive compounds from plastic-derived feedstocks. This advancement has the potential to transform industries related to bio-colorants, biotherapeutics, bio-nutraceuticals, biosurfactants, and biomaterials.

3. Data summary

According to the TwInn4MicroUp project structure—as described in detail in the GA— the research component that is expected to generate scientific data is organized within ***WP3:*** *Synthetic Microbial Biotechnology for Plastic Waste Upcycling*. WP3 focuses on the development of microbial strains that will be used to upcycle pre-treated plastic waste into valuable products, such as bio-pigments, biopolymers, bio-surfactants, and bio-oil. The research approach to be taken is inherently interdisciplinary by nature, combining concepts and methodologies from various scientific fields, i.e., polymer engineering, microbiology, molecular biology, bioengineering, fermentation, and material science. This is also illustrated by the three separate objectives (O) that have been formulated within WP3, namely: ***O3.1:*** *Generation of plastic waste-derived feedstock through green bio/mechano/chemical technologies*; ***O3.2:*** *Development of bacterial strains for utilisation of plastic waste-derived feedstock*; ***O3.3:*** *Development of yeast strains for utilisation of plastic waste-derived feedstock.*

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

The data generated in this project will originate from laboratory experiments conducted at all partners institutions, with methodologies including but not limited to: (i) mechano-green chemical reactive extrusion, microwave, and ultrasonication processes (TUS); (ii) Fourier-transform infrared spectroscopy, scanning electron microscopy, and differential scanning calorimetry (TUS); (iii) gel electrophoresis, UV/Vis spectroscopy, high pressure liquid chromatography, and gel permeation chromatography (NTUA); (iv) bacterial growth and fermentation logs, gel electrophoresis, NMR spectroscopy, DNA sequencing, mass spectrometry coupled to liquid chromatography (IMGGE); mass spectrometry couple to liquid or gas chromatography (UNIBA). Detailed metadata and documentation will be provided to ensure the transparency and reproducibility of all data.

To serve our experimental design and inform the methodological approaches to be taken, TwInn4MicroUp researchers will also gather, analyse, and reuse research data from published scientific journal papers, including available data sections and supplementary materials. They will also utilize data stored in general or domain-specific repositories. Researchers will comply with reuse license terms and properly cite the original data and its creators. Given the increasing significance of open data within the Open Science policy, open data repositories will also be assessed for relevant and useful datasets. **Table 1** lists the main data sources and repositories that TwInn4MicroUp researchers will explore.

Table 1. Selected data sources and repositories.

SOURCE	LINK	DESCRIPTION	OPEN POLICY
Google Scholar	scholar.google.com	Search engine; indexes full text or metadata; academic content	Open; Restricted
Google Dataset	datasetsearch.research.google.com	Search engine; indexes metadata; broad content	Open; Restricted
Zenodo	zenodo.org	Repository; integrates with other repositories and tools; broad content	Open; Restricted; Embargoed
Europe PMC	europepmc.org	Repository; links to external datasets; biomedical and life sciences research articles	Open; Restricted

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

SOURCE	LINK	DESCRIPTION	OPEN POLICY
ELIXIR Core Data Resources	elixir-europe.org/platforms/data	Set of European databases and repositories; evaluated and selected; biological data	Open (CC0; CC-BY; CC-BY-SA)*
European Open Science Cloud (EOSC) - EU Node	open-science-cloud.ec.europa.eu/resources	Digital platform providing access to network of repositories and services; supports research workflows	Open
Horizon Results Platform	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform	Repository for key exploitable results from EU-funded research and innovation projects	Open
European Data	data.europa.eu	Open data portal; international, EU, national, regional, local and geo data portals; indexes metadata	Open
Repository Directories			
Open Access Infrastructure for Research in Europe (OpenAIRE)	catalogue.openaire.eu/home	Registry of research data repositories; offers tools and services related to Open Science	N/A**
re3data	re3data.org	Global directory of research data repositories	N/A
OpenDOAR	https://v2.sherpa.ac.uk/opendoar	Global directory of open access repositories	N/A

** Creative Commons (CC) Licence Type (https://creativecommons.org/share-your-work/cclicenses/), **CC0:** public domain dedication; **CC-BY:** credit must be given to the creator; **CC-SA:** adaptations must be shared under the same terms; ** N/A: not applicable*

Aligning with the specific call objectives (HORIZON-WIDERA 2023-ACCESS 02-02), the TwInn4MicroUp project aims at not only enhancing the scientific and technical competence of NTUA, but also reinforcing its innovation capabilities, consolidating expertise and promoting entrepreneurship and innovation; these aims correspond to the formulated general project objectives **O3** and **O4**. Within the scope of meeting these general objectives, WP4 includes **O4.1:**

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Strengthening NTUA's grant proposal preparation and patent application, focusing on intellectual property assessment, compliance with patent laws, and crafting clear patent claims, while WP5 includes **O5.3:** *Promote and strengthen collaboration synergism between academia and industry*, focusing on establishing a portfolio of solutions at the Synthetic Microbial Biotechnology field and supporting the development of the initial business plans to verify the economic viability of the selected solutions to facilitate technology transfer. To meet these goals, the TwInn4MicroUp consortium will explore the existing landscape of intellectual property (IP) rights via market analysis, including not only patents, but also machine designs and trademarks. Said inquiry will be performed through the European Patent Office[2] and the available tools therein, i.e., the European Publication Server (EPO)[3] that offers free online access to all the European patent documents published by the EPO, and the European Patent Register[4], that includes procedural and legal information on European patent applications. Additionally, Google Patents[5] and the United States Patent and Trademark Office[6] will be utilized as search engines for relevant registries. Partners will also use data from their experience, partner IP backgrounds, and related HORIZON projects (e.g., BioICEP[7] and EcoPlastiC[8]) relevant to microbiome collection, isolation, culturing, and bioproduct production and formulation. The data collected will be used to determine the protection methods for the newly created IP within the TwInn4MicroUp project, which includes novel bioprocesses for producing bioproducts such as biopigments and biosurfactants. Additionally, this data will help prepare a portfolio of solutions in the Synthetic Microbial Biotechnology field. The entire process will be supervised and evaluated by the Project's Intellectual Property Rights and Exploitation Board (IPREB; **Annex VIII**).

Types of Data

The TwInn4MicroUp project is anticipated to produce and utilize both qualitative and quantitative data, including raw, abstracted, analysed, and literature data. The expected types of data include

[2] https://www.epo.org/en
[3] https://www.epo.org/en/searching-for-patents/technical/publication-server
[4] https://www.epo.org/en/searching-for-patents/legal/register
[5] https://patents.google.com/
[6] https://www.uspto.gov/patents/search
[7] https://cordis.europa.eu/project/id/870292
[8] https://cordis.europa.eu/project/id/101046758

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

numerical (datasets, spreadsheets); textual (manuals, protocols, methods, laboratory notebooks, reports); programming, spectral; DNA and protein sequences; statistical, mixed media (image, audio, video); presentations.

Data Formats: DAT, TXT, OPJ, XLSX, CSV, JSON, XML, JPG, JPEG, TIFF, RDF, PY, MD, PNG, BMP, SPC, FASTA, CMB, DOCX, PDF, PPTX, HTML, AVI, MP4, FLAC, ZIP, PDF/A.

***Expected Data Size*:** 0.5 – 1.0 Tb

TwInn4MicroUp partners will align their choice of data formats with good open science practices, adhering to specific standards recognized by data repositories and the research community. This approach will facilitate the sharing and long-term re-use of data in accordance with the FAIR principles. Some data formats may be dictated by the use of specialized software and laboratory equipment, in which cases, additional information will be provided in a readme.txt file (e.g., software name, license version, download link, installation instructions). Several repositories offer lists of preferred formats for successful long-term preservation and re-use. Accordingly, **Table 2** presents the recommended formats for the types of data to be generated in the TwInn4MicroUp project.

Table 2. Expected types and formats of TwInn4MicroUp data outputs.

DATA TYPE	DIGITAL CONTENT	RECOMMENDED FORMATS	OTHER ACCEPTABLE FORMATS
Textual	▪ Protocols ▪ Manuals ▪ Reports	▪ Plain text (DAT, CSV, TXT, UTF-8, UTF-16 with BOM) ▪ Open Office (ODT) ▪ Rich text format (RTF) ▪ Archival PDF/A (PDF)	▪ MS Office (DOC, DOCX) ▪ PDF
Numerical	▪ Datasets ▪ Spreadsheets	▪ ASCII or Unicode ▪ Comma Separated Values (CSV) ▪ Delimited Text (TXT) ▪ Compressed format (ZIP)	▪ MS Office (XLSX, XLS)
Experimental	▪ DNA sequences ▪ Spectral data ▪ FTIR ▪ DSC ▪ HPLC ▪ SEM	▪ FASTA ▪ TXT ▪ CSV ▪ PDF ▪ SPC ▪ CMB	

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

DATA TYPE	DIGITAL CONTENT	RECOMMENDED FORMATS	OTHER ACCEPTABLE FORMATS
	▪ NMR ▪ GC-MS ▪ LC-MS ▪ Reports	▪ XLXS ▪ JPEG ▪ PNG ▪ DOCX ▪ mzML ▪ CDF	
Image	▪ Pictures	▪ JPEG ▪ PNG ▪ TIFF ▪ PDF/A	▪ JPE ▪ JPEG2000 ▪ BMP
Audio/Video	▪ Recordings ▪ Movies	▪ FLAC ▪ AIFF ▪ WAVE ▪ M-JPEG2000 ▪ AVI	▪ MP3 ▪ MP4
Presentation	▪ Power Point presentations	▪ PPT ▪ PPTX ▪ PDF ▪ PDF/A	

Research data generated and deposited in appropriate repositories, once deemed non-commercially valuable or after securing appropriate IP protection, can be re-used by researchers and scientists working on microbial plastics upcycling, depolymerizing plastic and converting it into new bioproducts. This data will be particularly valuable to researchers in fields such as Biotechnology, Materials Science, and Chemical Engineering, who are focused on developing sustainable solutions for plastic waste. Additionally, the open datasets from TwInn4MicroUp will be relevant to various sectors related to chemicals and plastics. These sectors, which often rely heavily on fossil raw materials and energy in their production and processing technologies, are particularly susceptible to the need for transitioning toward circular models. Companies in these industries can leverage the data to innovate and optimize their processes, reducing their environmental impact and enhancing sustainability. Moreover, policymakers and regulatory bodies can use the data to inform decisions and create guidelines that promote the adoption of circular economy practices. Educational institutions and students can also benefit from the data, using it for academic research, projects, and to gain insights into cutting-edge biotechnological advancements.

As the TwInn4MicroUp DMP will continue to develop as a dynamic document throughout the project, details regarding the data sources used (**Table 1**) as well as the digital files produced

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

(Table 2) will be periodically updated in future versions. Additionally, Annex I will be listing the generated data with a short description and open access conditions.

4. FAIR data

4.1. Making data findable, including provisions for metadata

Internal Data Organization

Internal procedures for directory organization, file naming, and data management will be implemented to ensure easy identification and distinction. The folder tree structure and naming conventions will align with the project's WP organization, with tasks and deliverables guiding the creation of sub-folders. Common file naming conventions, as outlined by DATAcc[9] and other sources, will be followed to ensure consistency, easy access, and interoperability across different systems. In detail, file names will consist of 1 to 60 alphanumeric characters, including underscores (_) and periods (.), and will contain at least the following information, in order or appearance:

- date, in the format recommended by the international standard ISO 8601[10] (YYYYMMDD, i.e., year-month-day)
- project acronym, i.e., TwInn4MicroUp
- task or deliverable number (Tx.y or Dx.y)
- an experiment identifier that is intuitive enough to allow deduction of the kind of data it refers to
- file version number with two digits in ascending order starting from 01, i.e., v01.

All fields will be separated by underscores, including word separation within the experiment identifier field. For example: **20250122_TwInn4MicroUp_T3.2_bacterial_performance_v01.csv**.

Global Metadata Standards

Research data, represented as digital content in the formats listed in Table 2, will be supported by rich metadata in accordance with the FAIR principles (Annex II), if they are either deemed open by the IPREB or have no restrictions (such as data protection rules, privacy, confidentiality, trade

[9] https://www.datacc.org/
[10] https://www.iso.org/iso-8601-date-and-time-format.html

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

secrets, security rules, IP rights, etc.). The TwInn4MicroUp researchers will adhere to the general standards of the DataCite Metadata Schema[11] and the Dublin Core™ Metadata Initiative[12] for the core metadata properties, to ensure accurate and consistent identification of research data for citation and retrieval purposes. The metadata will document exactly how the data were generated and provide the context for proper interpretation. Search keywords will also be provided, to facilitate high discoverability. A persistent identifier (PID) will be assigned to each dataset, either via the digital object identifier (DOI) system[13] or the Handle system[14]. To achieve this, trusted repositories that offer automatic PID assignment will be chosen (**Annex III**). Additionally, repositories that use the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH)[15] to facilitate metadata harvesting and indexing, will be preferred. This protocol is widely adopted, due to the provision of a standardized and efficient way to expose metadata, making it accessible to various service providers and enhancing the discoverability of the data. In addition to the above metadata standard, the consortium will also consider the use of specific disciplinary standards, as listed in **Annex IV**. To ensure that secondary users can harvest, understand, and reuse the data generated by the TwInn4MicroUp project, the partners will create rich metadata in a "readme.txt" format for each open-access dataset. This metadata will serve as the foundation for publishing research results. A recommended template including detailed explanations has been adopted from Cornell Data Services[16] and is available in **Annex V**. The metadata for each dataset will include the following essential details to facilitate discovery by both human and computer users:

- Title (descriptive, allowing users to identify the general content and purpose)
- PID (issued by selected trustworthy, long-term repositories)
- Names of creator(s) (name, ORCiD[17], institution, address, email)
- Creation date (YYYYMMDD)
- Geographic location of data collection (latitude and longitude, or city and country)

[11] https://schema.datacite.org/
[12] https://www.dublincore.org
[13] https://www.doi.org/
[14] https://doi.org/10.17487/RFC3650
[15] https://www.openarchives.org/pmh/
[16] https://cornell.app.box.com/v/ReadmeTemplate
[17] https://orcid.org/

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

- Funding Statement (information about funding sources that supported the collection of the data, e.g., "The data were generated as part of the research carried out through the TwInn4MicroUp project, funded under the HORIZON EUROPE program (HORIZON-WIDERA-2023-ACCESS-02, GA No. 101159570), Sep 2024 – Sep 2027")
- Sharing/access information (e.g., licenses/restrictions, other data locations, sources, if data derived from other source(s), required software, and recommended citation)
- Dataset description (e.g., list and types of files and their relationships)
- Methodological information (e.g., methods and instrument)
- Data-specific information (e.g., variables, their definitions, and units of measurement)
- Keywords

It is important to consider that specific disciplines and repositories may dictate the content and format of metadata[18,19]. Given the interdisciplinary nature of the TwInn4MicroUp project, it may be necessary to define and include additional descriptive information in the dataset metadata as the project progresses. The OpenAIRE guidelines for data archiving will be utilized to support this effort [20].

4.2. Making data accessible

TwInn4MicroUp will adhere to open science principles as part of the HE programmes, ensuring open access to research data. Access rights to this data will be governed by the CA. The project aims to publish a minimum of five scientific papers in high-impact, open-access journals and present findings at seven scientific conferences. The research data supporting the conclusions of these publications, together with the corresponding metadata, will be deposited in trusted repositories no later than the publication date of the respective papers, and will be accessible through universally implementable protocols, such as the hypertext transfer protocol (HTTP) or the file transfer protocol (FTP)[21]. Any earlier disclosure of data will be contingent upon discussions

[18] https://rdamsc.bath.ac.uk/scheme-index
[19] https://fairsharing.org/
[20] https://guidelines.openaire.eu/en/latest/data/index.html
[21] https://www.go-fair.org/fair-principles/metadata-retrievable-identifier-standardised-communication-protocol/

at the consortium level and the decision of the IPREB, which oversees knowledge management and protection activities. The data will remain available and findable for a minimum of 5 years after the end of the project. This duration ensures that the data can be accessed and utilized by the research community and other stakeholders for an extended period, maximizing its impact and reusability. Metadata will be guaranteed to remain available even after the data itself is no longer accessible. This ensures that the information about the data, including its origin, structure, and context, remains discoverable and can be used to understand the research and its findings. Comprehensive documentation or references about any software required to access or read the data will be included in the metadata readme file (see **Section 4.1** and **Annex V**). This documentation will provide detailed instructions on how to use the software, ensuring that future users can effectively access and utilize the data. **Annex III** lists several general and disciplinary repositories that assign globally unique PIDs and allow submitter-specified metadata uploads. This metadata is always publicly available and machine-readable/interoperable. These repositories have clearly defined licensing policies, offering submitters the option to choose a license. Additionally, they have long-term preservation plans for archived data. In addition to the recommended repositories, TwInn4MicroUp partners will also use repository directories (**Table 1**) to find domain-specific repositories, as well as to check trustworthiness criteria[22].

Given the innovative nature of this project, results that are commercially exploitable and require IP protection (e.g., patents, non-disclosure agreements (NDAs), trade secrets) will be restricted, embargoed, or have limited access, with contact details provided for potential users. The exact length of the embargo will be determined by the IPREB, considering the specific needs of the project, the requirements for IP protection, and the necessity for timely data availability. During the embargo period, metadata about the data will be made publicly available under a Creative Commons (CC) Public Domain Dedication (CC0)[23] licence to facilitate discoverability. Once the embargo period expires, the data will be released to the public, ensuring compliance with open science principles and maximizing the impact and reusability of the research data.

[22] https://scienceeurope.org/media/4brkxxe5/se_rdm_practical_guide_extended_final.pdf
[23] https://creativecommons.org/share-your-work/cclicenses/

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

If the newly generated IP results from research conducted by a single partner institution, that institution, as the data owner, will decide on the possibility and timing of data release, in accordance with its legitimate interests and internal procedures. For IP foreground created by two or more partners, the provisions of the CA will apply. Any undefined aspects will be addressed through a new joint IP ownership and management agreement, which will specify which datasets must be restricted and the duration of any embargo. In the updated version of the DMP (Deliverable D1.3– M17), partners will update **Annex III** to include the selected appropriate data repositories for depositing research data according to the FAIR principles, facilitating direct handling of data requests by submitters, and add details regarding the following:

- Procedures for appraising and selecting datasets for long-term preservation
- Criteria for retaining or destroying data for contractual, legal, or regulatory purposes
- Anticipated research uses and users for the data
- Selection of specific tools for data access and re-use by potential users
- Sustainability of software required for accessing the data

4.3. Making data interoperable

To ensure syntactic, semantic, and organizational interoperability of our (meta)data, we will use an accessible, shared, and broadly applicable language for knowledge representation, we will utilize vocabularies that follow the FAIR principles, and include qualified references to other (meta)data[24]. We will adhere to established data and metadata vocabularies, standards, formats, and methodologies, following community-endorsed best practices. These practices are summarized below:

Standardized Formats and Ontologies

Adopting standardized data formats and ontologies, following guidelines from the DataCite Metadata Schema and the Dublin Core™ Metadata Initiative, will facilitate data sharing and understanding across various systems and disciplines. The Resource Description Framework (RDF) will be employed for data interconnection and exchange. In cases where it is unavoidable

[24] https://doi.org/10.1038/sdata.2016.18

to use uncommon or project-specific ontologies or vocabularies, we will provide mappings to more commonly used ontologies. This will ensure that our data remains interoperable with other datasets and systems. Tools like Agreement Maker Light (AML)[25] and LogMap[26] will be used to facilitate these mappings. We will openly publish any generated ontologies or vocabularies to allow for their reuse, refinement, or extension by other researchers.

Controlled Vocabularies and Taxonomies

Implementing controlled vocabularies and taxonomies is essential for maintaining consistency in data description and categorization, thereby ensuring data interoperability and reusability.

Persistent Identifiers

Utilizing persistent identifiers, DOIs, for datasets, will ensure reliable referencing and long-term access to data.

Community-Endorsed Data Standards

Leveraging data standards endorsed by relevant research communities, such as those curated by the FAIRsharing[27] registry, will significantly enhance data interoperability.

Machine-Readable Metadata

Ensuring that metadata is machine-readable will facilitate automated data processing and integration, supporting the FAIR principles by making data more accessible and interoperable.

Qualified References to Other Data

Our data will include qualified references to other datasets via persistent identifiers and clear cross-references to ensure that the relationships between datasets are well-documented and easily navigable.

[25] https://github.com/AgreementMakerLight/AML-Project
[26] https://github.com/ernestojimenezruiz/logmap-matcher
[27] https://fairsharing.org/

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

As outlined in **Table 2**, data generated within the TwInn4MicroUp project will be prepared and stored in standard formats compatible with available software applications. Experimental investigation datasets will be represented in well-structured tabular numerical data, initially stored in XLSX format and converted to machine-readable CSV format for repository deposition. The following guidelines will be applied to ensure proper spreadsheet preparation:

- Descriptive headings in a single row for each column.
- Spreadsheets starting from cell A1.
- Titles and legends for each spreadsheet.
- Separate files for each spreadsheet within the dataset.
- Avoidance of non-alphanumeric characters, including commas.
- No merged cells or colour coding.
- Exclusion of charts, comments, or other tables from spreadsheets.

Non-numerical research data will be prepared in machine-readable formats such as RDF, XML, and JSON. Trusted repositories will be selected based on their support for these formats and their methods for defining semantic models and preparing relationships within datasets. Metadata will initially be prepared in a "readme" style but can be converted to RDF format if greater interoperability is required by the repository. When data in the dataset is based on other data with assigned PIDs, the dataset will be linked to these references through citation via PID. Cited references will be listed in the metadata description, detailing their scientific relationship with the TwInn4MicroUp dataset.

4.4. Increase data re-use

The proposed structure of datasets metadata (see **Section 4.1** and **Annex V**) encompasses additional information related to research methodology, sampling, experimental conditions, variables, units of measurement, as well as procedures for processing and analysing experimental data. This comprehensive metadata enables the validation of the conducted analysis and displayed results, as well as the reuse of the data. The metadata will be licensed under a CC0 licence in accordance with the GA provisions. The openness of the datasets to which the metadata refers will be evaluated and decided by the IPREB and abide by the CA. Open research data will be licensed

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

under the latest version of the CC Attribution 4.0 (CC BY)[28], which requires attribution of authorship. For large datasets where reuse under this license would be problematic, the CC0 license will be applied, subject to the authors' agreement. The provenance of the data will be systematically documented in the metadata.

Data deposited by TwInn4MicroUp partners in open repositories will be available for use by third parties (researchers, companies, others) under the conditions specified in the license (CC BY or CC0). Data will be retained in the repositories for a minimum of 5 years after the project's conclusion. All published scientific papers and conference proceedings will include a Data Availability Statement, indicating where the associated data can be accessed (open data repository, link, and PID) and under what conditions (details of any access restrictions and justifications, e.g., ethical, legal, or commercial reasons). Examples of these statements are provided in **Annex VI** for various scenarios that may arise during the project. If the data generated during the project are linked to exploitable results and are, therefore, only accessible upon request, the authors will provide a contact email address.

The TwInn4MicroUp project will take into consideration the Joint Declaration of Data Citation Principles[29], that cover the purpose, function, and attributes of citations, emphasizing the need for citation practices that are both human-understandable and machine-actionable. By incorporating these principles, we will ensure that our data citations facilitate both human and machine access, enhancing the reusability and impact of our research outputs.

Data quality assurance will be maintained through: (i) standardized collection procedures (e.g., device calibration, replicate sampling, and standardised data capture); (ii) (automated) data entry validation; (iii) data cleaning and transformation; (iv) data documentation and metadata generation; (v) secure storage and regular backup; (vi) data quality monitoring and assessment, via regular audits and quality metrics monitoring; and (vii) staff training and familiarisation with standards and procedures.

[28] https://creativecommons.org/licenses/by/4.0/deed.en
[29] https://doi.org/10.25490/a97f-egyk

5. Other research outputs

During the TwInn4MicroUp project, we anticipate generating additional research outputs alongside experimental data, including new materials, software, experimental protocols, confidential know-how, patents, scientific publications, press releases, and internal reports. The project will adhere to the FAIR principles to ensure all outputs are findable, accessible, interoperable, and reusable by third parties. Typically, sharing research outputs may take months or even years after data generation due to time-consuming processes like publishing in high-impact journals or obtaining patent approvals. Given the uncertainties and risks inherent in projects involving breakthrough technologies and planned innovations, it is challenging to predict when these innovations will be ready for sharing, whether through patent databases or other means. Consequently, this version of the DMP provides a draft plan for handling these research outputs, outlining the methods and conditions for sharing them in compliance with GA requirements.

Research outputs, both digital (e.g., workflows and protocols) and physical (e.g., new materials and samples), unless restricted by legal interests, IP protection, or commercial exploitation limitations, will be assigned a unique PID to ensure unique citation and easy findability. This will enable unique citations for the entire output or its individual elements that may be cited separately. Comprehensive metadata will be provided, detailing the creation, context, and relevant attributes of each output. Digital outputs will be stored in repositories that support open access protocols, while physical outputs will be made available under specified conditions, including any necessary agreements or permissions. Standardized formats and protocols will be used for digital outputs to ensure interoperability, and references to related datasets and research will be included. Clear and accessible licenses (e.g., CC BY for digital outputs, Material Transfer Agreements for physical outputs) will be applied, and the origin and history of each output will be documented. Data quality assurance will be maintained through standardized procedures for the creation and validation of both digital and physical outputs (see **Section 4.4**). **Table 3** shows the basic principles for sharing TwInn4MicroUp research outputs, as well as other types of written outputs, such as papers and/or presentations from conference proceedings, position papers, policy briefs, and general communication material such as press releases. In following versions of the DMP this table will be updated with more concrete information.

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Table 3. Research outputs sharing approach.

RESEARCH OUTPUTS	TYPE	PREPARATION TOOLS	MEANS OF SHARING
Monomers/oligomers of selected pre-treated plastics	Protocol / Material	▪ Laboratory equipment	▪ Material Transfer Agreements ▪ Sharing within the consortium ▪ Restricted Sharing for Patent Protection
Engineered or evolved bacteria for plastic upcycling	Protocol / Material	▪ Laboratory equipment	▪ Material Transfer Agreements ▪ Sharing within the consortium ▪ Restricted Sharing for Patent Protection
Engineered *Yarrowia lipolytica* for plastic upcycling	Protocol / Material	▪ Laboratory equipment	▪ Material Transfer Agreements ▪ Sharing within the consortium ▪ Restricted Sharing for Patent Protection
Fermentation and downstream processing for bioproducts production	Protocol / Material	▪ Laboratory equipment	▪ Sharing within the consortium ▪ Restricted Sharing for Patent Protection
Scientific papers	Publication	▪ Writing ▪ Data FAIRification ▪ Metadata preparation ▪ OA journal choice ▪ Submission ▪ Deposition on repository	▪ OA journals ▪ Trusted repositories ▪ TwInn4MicroUp website ▪ Partners' websites
Conference proceedings	Publication / Presentation	▪ Conference identification ▪ Writing/Presentation preparation	▪ Conference book ▪ TwInn4MicroUp website
Position papers / Policy briefs	Publication / Presentation	▪ Stakeholders' identification ▪ Writing	▪ TwInn4MicroUp website ▪ Partners' websites ▪ Social media
Communication materials for public audience	▪ Newsletters ▪ News articles ▪ Flyers ▪ Press releases	▪ Stakeholders' identification ▪ Content writing ▪ Designing based on project's visual identity	▪ TwInn4MicroUp website ▪ Partners' websites ▪ Social media ▪ Project events ▪ Attending events ▪ School visits ▪ Laboratory tours ▪ Conventional newspapers ▪ TV and radio

All peer-reviewed scientific publications that will be generated by the TwInn4MicroUp project will be made publicly available immediately upon acceptance (Author Accepted Manuscript; AAM) by depositing them in selected trusted repositories listed in **Annex III**, in a machine-readable format and in accordance with the FAIR principles, while respecting all GA requirements related to licenses, metadata and data validation. The final versions of these papers (Version of

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Record; VoR) will be published in OA journals under an open CC BY[30] licence The possibility of publishing on Open Research Europe[31] will also be considered. As described in detail in **Section 4**, the research data that underpins the conclusions of these publications will also be deposited in trusted repositories and appropriately linked to the publication. PIDs will be assigned to the publications and ORCiD identifiers will be listed for each author. The selection of appropriate journals will be based on both scientific relevance and OA criteria as defined by the HE regulations, and will be guided by specialised tools, such as the Journal Checker Tool[32], the Sherpa Romeo[33], and the Directory of Open Access Journals[34].

Publishing in hybrid OA journals[35] is possible, but in that case article processing charges will not be paid from the project budget. This is not the case for publication in mirror/sister OA journals[36].

If the research results intended for publication may threaten potential patentability or conflict with any previously mentioned restrictions, methods of IP protection (such as patent applications) will be considered first. Following this, the paper must be approved by the IPREB before being submitted to a journal or presented at a scientific conference. Researchers working on the project and do not have clearly defined non-disclosure rules in their work contract, will be required to sign an NDA. Throughout the project, the IPREB may establish a series of rules that TwInn4MicroUp researchers should follow for knowledge management and IP protection, including those related to the publication of scientific papers.

The scientific publications plan is a crucial component of the DMP, facilitating ongoing planning and monitoring of the publication status of project-related scientific papers. This plan will be regularly updated (**Annex VII**) and included in future versions of the DMP.

[30] https://creativecommons.org/licenses/by/4.0/
[31] https://open-research-europe.ec.europa.eu/
[32] https://journalcheckertool.org/
[33] http://www.sherpa.ac.uk/romeo/index.php
[34] www.doaj.org
[35] ***Hybrid journals and books*** *offer some content as open access, while other parts require subscriptions or payments. They provide open access to specific content when an open access fee is paid by the authors or institutions, either ad hoc or through institutional agreements with publishers.*
[36] ***Mirror and sister journals*** *are newly established open access versions of existing subscription journals. They often share the same editorial board, aims, scope, and peer review processes as the original journal but have a different ISSN. In Horizon Europe, they are considered open access publishing venues, not hybrid journals.*

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

6. Allocation of resources

The implementation of open science practices and effective data management requires substantial human, financial, and material resources. Managing research data and outputs is a critical component throughout the project, encompassing data collection, curation, storage, preservation, security, quality assurance, allocation of PIDs, metadata provision, licensing, and the establishment of data-sharing protocols.

Data and output management, along with their alignment with the FAIR principles, are embedded in all WPs of the TwInn4MicroUp project. Within ***WP1:*** *Project Management and Coordination,* ***Task 1.3*** *(DMP Development)* is specifically intended for data management, through the preparation and monitoring of the DMP implementation. Effort is planned for monitoring several key aspects, such as data types and their generation method, metadata provision, storage and analysis procedures, data protection and security measures, data sharing and re-usage protocols, and long-term preservation strategies. Significant efforts are also required for data management in ***WP3:*** *Synthetic Microbial Biotechnology for Plastic Waste Upcycling*, the research component of the TwInn4MicroUp project, where a substantial amount of data is expected to be collected and generated. Moreover, ***WP6:*** *Outreach, Communication, and Dissemination* comprises all activities pertinent to the outreach towards relevant stakeholders, from academia to industry to the general public, clearly associated with data management and open practices (see *Deliverable 6.1: Dissemination, Exploitation and Communication plan*).

All costs related to data FAIRification, data quality assurance, and data management have been identified and allocated in the collective project budget. In addition to a portion of staff costs, estimated per partner and WP, other direct costs are outlined in the budget breakdown, including OA publishing fees, conference fees, travel costs for participation, IP protection measures, and website creation and maintenance. Any data management costs not included in the original budget will be reviewed by the GNA, and reallocation will be decided if deemed necessary.

In the TwInn4MicroUp project, data and output management responsibilities are shared among partners (**Table 4** and **Annex VIII**). NTUA, as WP1 leader and project coordinator, coordinates the overall DMP, including its review and revisions, alongside the appointed GNA members representing all partners. Each researcher is responsible for data collection, processing, analysis,

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

FAIRification, and metadata preparation, following DMP guidelines and disciplinary standards. WP leaders oversee data quality control within their work packages, while the highest level of control is managed by GNA members. Researchers will be supported by institutional IT teams for data storage, backup, and archiving. All research data, including raw and processed data and datasets related to publications, will be deposited in trusted repositories managed by designated staff. Data sharing and dissemination will occur after analysis of limitations and approval by IPREB. Long-term data preservation, whether in public or partner repositories, will be decided by consortium members and finalized by the IPREB.

Table 4. Data management responsibilities within the TwInn4MicroUp project.

DATA MANAGEMENT RESPONSIBILITIES	NTUA	TUS	IMGGE	UNIBA	GNA*
DMP Coordination	WP1 Leader				
DMP Reviews & Revisions	Project Coordinator				Members
Data Acquisition	Researchers	Researchers	Researchers	Researchers	
Metadata Provision	Researchers	Researchers	Researchers	Researchers	
Data Quality Assurance	WP1 Leader	WP4 Leader	WP6 Leader	WP2 Leader	Members
	WP3 Leader				
	WP5 Leader	Researchers	Researchers	Researchers	
	Researchers				
Data Storage & Backup	Researchers	Researchers	Researchers	Researchers	
	IT Team	IT Team	IT Team	IT Team	
Data Archiving	IT Team	IT Team	IT Team	IT Team	
Datasets Sharing**	Authors	Authors	Authors	Authors	Members
Research Outputs Sharing**	Authors	Authors	Authors	Authors	Members

** GNA: general assembly; ** upon approval by IPREB*

7. Data security

To ensure data security, the TwInn4MicroUp project will implement stringent measures for secure storage, controlled access, data transfer, and long-term preservation. Research data and digital outputs (Table 2) will be securely stored within the institutional storage systems of project partners, managed by their respective IT teams. Additionally, data will be shared among project researchers via a dedicated Google Drive (GD)[37] project server, with restricted access controlled

[37] https://workspace.google.com/products/drive/

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

by NTUA. For data in transit, GD employs Hypertext Transfer Protocol Secure (HTTPS) with Transport Layer Security (TLS) 1.2/1.3, ensuring protection against interception. For data at rest, it utilizes Advanced Encryption Standard (AES)-256 encryption; however, as encryption keys are managed by Google, project researchers will encrypt select sensitive data before upload using open-source tools such as 7-Zip[38], Cryptomator[39], or VeraCrypt[40]. While the project does not anticipate generating sensitive personal data, any such data will be anonymized or pseudonymized in compliance with General Data Protection Regulation (GDPR) and ethical guidelines and encrypted prior to storage. Regular backups of GD content will be conducted on NTUA institutional or project-designated servers. Non-confidential research outputs, such as published scientific manuscripts, will be archived on the TwInn4MicroUp website. For non-digital outputs, responsible partners will ensure proper preservation following institutional policies and best practices.

For long-term preservation, final datasets will be deposited in trusted repositories (**Annex III**) to ensure accessibility and reusability. Comprehensive metadata and documentation will be maintained to support data discoverability and adherence to FAIR principles. These measures align with EU regulations and best practices, ensuring data integrity, confidentiality, and availability throughout the project lifecycle and beyond.

8. Ethics

The TwInn4MicroUp project is designed to meet the ethical and legal standards necessary for the acceptance and adoption of its results by end users. Ethically, the project will adhere to the guidelines outlined in the GA and comply with relevant international and national laws, maintaining the highest standards of research integrity and information security. As stated in the "Ethics Self-assessment" section of the GA, the TwInn4MicroUp consortium declares that no ethics issues are foreseen in the project.

[38] https://www.7-zip.org/
[39] https://cryptomator.org/
[40] https://www.veracrypt.fr/code/VeraCrypt/

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

9. Other issues

Relevant national, funder, sectorial, institutional, or departmental procedures for data storage, sharing, and security are listed in the tables below per TwInn4MicroUp partner institution (**Table 5**, **Table 6**, **Table 7**, and **Table 8**).

Table 5. Data storage and security procedures (NTUA).

POLICY	DESCRIPTION
Internal Data Storage	▪ Local Network Attached Storage (NAS) ▪ Configured Redundant Array of Independent Disks (RAID) system to increase reliability
Back-up	Dedicated local hard disks for periodical backups
Data Sharing	HTTPS server

Table 6. Data storage and security procedures (TUS).

POLICY	DESCRIPTION
Internal Data Storage	NAS
Back-up	Dedicated local hard disks for periodical backups
Data Sharing	TUS repository

Table 7. Data sharing and data security procedures (IMGGE).

POLICY	DESCRIPTION
Internal Data Storage	▪ NAS ▪ RAID system to increase reliability
Back-up	Dedicated local hard disks for periodical backups (automatically, by our scripts)
Data Sharing	▪ SFTP server ▪ IMAGINE repository

Table 8. Data sharing and data security procedures (UNIBA).

POLICY	DESCRIPTION
Internal Data Storage	Garrbox cloud service and local hard disks
Back-up	Dedicated local hard disks for periodical back-ups

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

POLICY	DESCRIPTION
Data Sharing	Garrbox cloud service

10. Bibliography

Accelerating the transition to full and immediate Open Access to scientific publications, cOAlition S, Coordinated by Science Europe, 2021.

AGA — Annotated Model Grant Agreement, EU Funding Programmes 2021-2027, v1.0, 2024.

Consortium Agreement, Project 101159570 — TwInn4MicroUp, Final Version, April 2024.

D6.4 Data Management Plan, Project 101046758 — EcoPlastiC, v1, 2023.

Data Management Plans in Horizon 2020: what beneficiaries think and what we can learn from their experience, Spichtinger D., [v2; peer review: 2 approved, 1 approved with reservations], Open Res Europe 1:42, 2022.

European Commission: Directorate-General for Research and Innovation and Waltman, L., Open metadata of scholarly publications – Open science monitor case study, Publications Office, 2019.

Facts and Figures for open research data, European Commission, accessed December 2024.

FAIR principles, The Future of Research Communications and e-Scholarship, accessed January 2025.

FAIRification process, GO FAIR, accessed December 2024.

File formats recommended by the UK Data Service, UK Data Service, accessed January 2025.

Grant Agreement, Project 101159570 — TwInn4MicroUp, Final Version, April 2024.

Guides for Researchers, How to comply with Horizon Europe mandate for publications, OpenAIRE, accessed January 2025.

Horizon Europe (HORIZON), HE Programme Guide, v4.1, 2024.

How to Appraise & Select Research Data for Curation, Whyte, A. & Wilson, A., DCC How-to Guides. Edinburgh: Digital Curation Centre, 2010.

How to Develop a Data Management and Sharing Plan, Jones S., DCC How-to Guides. Edinburgh: Digital Curation Centre, 2011.

Metadata Standards Catalog, Research Data Alliance, accessed January 2025.

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

OpenAIRE Guide: Raw data, backup and versioning: What you need to know to preserve your research data, Venkataraman, S., Moura P., 2020.

OpenAIRE Webinar: Horizon Europe Open Science requirements in practice, England J., Malaguarnera, G., Príncipe, P., v1, 2022.

Practical Guide to the International Alignment of Research Data Management (Extended Edition), Science Europe, v1, 2021

Research Data Management Handbook, OpenAIRE, accessed December 2024.

Research Data Management Plan: guidance and resources, Dublin City University, 2022.

Strategic Approaches to, and Research Assessment of, Open Science, Morris J., Saenen, B., v1, 2024.

The FAIR Guiding Principles for scientific data management and stewardship.Wilkinson, M. D. et al. Sci. Data 3:160018, 2016.

Where is Open Science in Horizon Europe, OPEN SCIENCE eu, 2022.

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Annexes

Annex I – Generated Datasets

No	DATASET TITLE	WP	RESPONSIBLE PERSON/PARTNER	DESCRIPTION	FORMAT	OPEN ACCESS LICENSE (CC BY or CC0)	RESTRICTIONS (with justification)	REPOSITORY / PID
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Annex II – FAIR Checklist

Datasets/Files

- Is the dataset in an open & trusted repository (if available)?
- Does the dataset have a registered DOI?
- Are data files in standard and/or commonly available open formats (as much as possible)?
- Are the data and/or metadata retrievable via an API and/or discoverable through an open search protocol?

README/Metadata

- Are all associated data files unambiguously named in the metadata and described including file types, software requirements and/or conversion information?
- Does the metadata include useful disciplinary notation and terminology? (e.g., SI units, common domain identifiers, acronyms explanations, field-specific jargon definitions)
- Does the metadata include machine-readable standards where available (e.g., ORCiDs for authors and/or data contributors)
- Are related articles referenced and linked in the metadata?
- Is a citation format for the dataset provided?
- Are any license terms, attributions, or terms of use clearly indicated?
- Is the metadata exportable in a machine-readable structured text-based format? (e.g., XML, JSON)

Additional tips for preparing your data for sharing

- You may choose to include raw data (as originally collected), processed data (*e.g.,* signals encoded), or both. The decision depends on what is most useful or common in a discipline or specifically required by a publisher or repository.
- Use file formats that are common and open as much as possible, including any discipline-specific data types if open formats are available.
- Use unambiguous filenames and organize the files logically according to your project (*e.g.,* by sample, treatment, method, *etc.*).

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Additional tips for documenting your data and files

- For an easy, low-barrier approach, use a ReadME template and save as a plain text document (.txt). Note that some repositories may provide specific documentation templates.
- List the data files included in the package, and/or describe the file naming schema and organization. Include their formats and any specific software requirements and/or conversion information if you have it.
- Describe methods of data collection and file structures and organization including useful notation about the data headers, units, sample identifiers, etc. Use standard or conventional terminology or nomenclature in your discipline.
- Reference associated articles, codes and related datasets. Include ORCiDs of all data contributors.

Additional tips for depositing your data in a repository

- Select a reputable data repository and upload dataset (publishers or funders may require specific repositories; many domain-specific repositories provide enhanced services and curation for specific data types).
- Make sure the repository provides a persistent identifier (e.g., DOI, handle, or other) and specifies conditions for others to access and re-use the data (such as a public domain declaration or Creative Commons attribution license; licensing policy may vary by repository).
- Provide a pre-formatted citation (and license attribution if appropriate) for the dataset on your website and other materials so users can easily copy and attribute, for example:
- Author(s). Dataset Title, Version. Data Repository (or Journal if appropriate). Year. DOI. (Date accessed) [License attribution if appropriate]

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call
HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Annex III –Repositories and Databases

Recommended repositories and databases

European Open Science Cloud (EOSC) - EU Node: digital platform providing access to network of repositories and services (open-science-cloud.ec.europa.eu/resources)

Europe PMC: provides comprehensive access to life sciences literature from trusted sources (europepmc.org)

Horizon Results Platform: repository for key exploitable results from EU-funded research and innovation projects (https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform)

European Data: the official portal for European data (data.europa.eu)

Zenodo: a general-purpose open research data repository for the preservation and availability of research, educational and informational content, built and developed by OpenAIRE and CERN (https://zenodo.org/)

Figshare: repository where researchers can make all of their research outputs available in a citable, shareable and discoverable manner (https://figshare.com/)

Dryad Data Platform: general-purpose open-source platform for data publication and digital preservation of a wide diversity of data types, in underlying repository with which it is integrated (https://datadryad.org/stash)

EUDAT: collaborative Data Infrastructure is one of the largest infrastructures of integrated data services and resources supporting research in Europe (https://www.eudat.eu/)

Dataverse: available as an open-source web application to share, preserve, cite, explore, and analyse research data, developed by the Institute for Quantitative Social Science in collaboration with the Harvard University (https://dataverse.org/)

ELIXIR: coordinates and develops life science resources across Europe so that researchers can more easily find, analyse and share data, exchange expertise, and implement best practices (https://elixir-europe.org/platforms/data/elixir-deposition-databases)

PAZy (Plastics-Active Enzymes Database): database that lists exclusively biochemically characterized plastic-active enzymes (https://pazy.eu/doku.php)

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

GenBank database: a part of the International Nucleotide Sequence Database Collaboration database, designed to provide and encourage access within the scientific community to the most up-to-date and comprehensive DNA sequence information (https://ftp.ncbi.nih.gov/genbank/)

Selected trusted repositories

to be defined in the updated version of DMP (Deliverable 1.3)

Selected databases

to be defined in the updated version of DMP (Deliverable 1.3)

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call
HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Annex IV – Disciplinary Metadata Standards

Source: Metadata Standards Catalog[41]

Molecular biology

ISA-Tab

The Investigation/Study/Assay (ISA) tab-delimited (TAB) format is a general-purpose framework with which to collect and communicate complex metadata (i.e., sample characteristics, technologies used, type of measurements made) from 'omics-based' experiments employing a combination of technologies. Created by core developers from the University of Oxford, ISA-TAB v1.0 was released in November 2008.

Minimum Information about any (x) Sequence (MIxS)

MIxS currently consists of three separate checklists: MIGS for genomes, MIMS for metagenomes, and MIMARKS for marker genes. To create a single-entry point to all minimum information checklists from the GSC and to the environmental packages, we created an overarching framework, the MIxS standard (publication in Nature Biotechnology). MIxS includes the technology-specific checklists from the previous MIGS and MIMS standards, provides a way of introducing additional checklists such as MIMARKS, and also allows annotation of sample data using environmental packages.

PDBx/mmCIF (Protein Data Bank Exchange Dictionary and the Macromolecular Crystallographic Information Framework)

Protein Data Bank (PDB) archive is the single worldwide archival repository of information about the 3D structures of proteins, nucleic acids, and complex assemblies, managed by the Worldwide PDB (wwPDB). The PDB Exchange Dictionary (PDBx) is used by the wwPDB to define data content for deposition, annotation and archiving PDB entries. PDBx incorporates the community standard metadata representation, the Macromolecular Crystallographic Information Framework (mmCIF), orginally developed under the auspices of the International Union of Crystallography (IUCr). PDBx has been extended by the wwPDB to include descriptions of other experimental

[41] https://rdamsc.bath.ac.uk/

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

methods that produce 3D macromolecular structure models such as Nuclear Magnetic Resonance Spectroscopy, 3D Electron Microscopy and Tomography.

REMBI (Recommended Metadata for Biological Images)

Recommended Metadata for Biological Images (REMBI) provides guidelines for metadata for biological images to enable the FAIR sharing of scientific data. REMBI is the result of the bioimaging community coming together to develop metadata standards that describe the imaging data itself, together with supporting metadata such as those describing the biological study and sample.

Repository-Developed Metadata Schemas

Some repositories have decided that current standards do not fit their metadata needs and so have created their own requirements.

Biotechnology

ISA-Tab

The Investigation/Study/Assay (ISA) tab-delimited (TAB) format is a general-purpose framework with which to collect and communicate complex metadata (i.e. sample characteristics, technologies used, type of measurements made) from 'omics-based' experiments employing a combination of technologies. Created by core developers from the University of Oxford, ISA-TAB v1.0 was released in November 2008.

ISA-TAB Nano

An extension of ISA-TAB specifying the format for representing and sharing information about nanomaterials, small molecules and biological specimens along with their assay characterization data.

MIBBI (Minimum Information for Biological and Biomedical Investigations)

A common portal to a group of nearly 40 checklists of Minimum Information for various biological disciplines. The MIBBI Foundry is developing a cross-analysis of these guidelines to create an intercompatible, extensible community of standards. The concept was realized initially through

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

the joint efforts of the Proteomics Standards Initiative, the Genomic Standards Consortium and the MGED RSBI Working Groups. The latest project to register with MIBBI is the MIABie guidelines for reporting biofilm research, as of January 2012.

Materials engineering

CIF (Crystallographic Information Framework)

A well-established standard file structure for the archiving and distribution of crystallographic information, CIF is in regular use for reporting crystal structure determinations to Acta Crystallographica and other journals. Sponsored by the International Union of Crystallography, the current standard dates from 1997. As of July 2011, a new version of the CIF standard is under consideration.

CSMD (Core Scientific Metadata Model)

A study-data oriented model, primarily in support of the ICAT data management infrastructure software. The CSMD is designed to support data collected within a large-scale facility's scientific workflow; however, the model is also designed to be generic across scientific disciplines. Sponsored by the Science and Technologies Facilities Council, the latest full specification available is v 4.0, from 2013.

EngMeta

EngMeta is an XML-based formal definition of information necessary to find, understand, reproduce and reuse data from engineering disciplines. The schema was defined together with engineers from aerodynamics and thermodynamics and lies a focus on computational engineering but is general enough to cover other engineering disciplines. EngMeta defines metadata-fields for the description of the components of the observed system (object of research), the observed variables, the spatial and temporal resolution of the observation and the steps taken in the research process to generate, process, analyse and visualize the data. It is based on existing standards like DataCite, PREMIS, CodeMeta and ExptML and is implemented as two metadata blocks for repositories based on the open-source repository platform Dataverse.

NeXus

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

NeXus is an international standard for the storage and exchange of neutron, x-ray, and muon experiment data. The structure of NeXus files is extremely flexible, allowing the storage of both simple data sets, such as a single data array and its axes, and highly complex data and their associated metadata, such as measurements on a multi-component instrument or numerical simulations. NeXus is built on top of the container format HDF5 and adds domain-specific rules for organizing data within HDF5 files in addition to a dictionary of well-defined domain-specific field names.

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call
HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Annex V – "Readme" File Template for Metadata

Source: Cornell Data Services[42]

This readme file was generated on [YYYY-MM-DD] by [NAME]

<help text in angle brackets should be deleted before finalizing your document>

<[text in square brackets should be changed for your specific dataset]>

GENERAL INFORMATION

Title of Dataset:

PID:

<provide at least two contacts>

Author/Principal Investigator Information

Name:

ORCID:

Institution:

Address:

Email:

Author/Associate or Co-investigator Information

Name:

ORCID:

Institution:

Address:

Email:

Author/Alternate Contact Information

Name:

ORCID:

Institution:

[42] https://cornell.app.box.com/v/ReadmeTemplate

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call
HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Address:

Email:

Date of data collection: <suggested format YYYYMMDD>

Geographic location of data collection: < latitude and longitude, or city and country >

Information about funding sources that supported the collection of the data:

SHARING/ACCESS INFORMATION

Licenses/restrictions placed on the data:

Links to publications that cite or use the data:

Links to other publicly accessible locations of the data:

Links/relationships to ancillary data sets:

Was data derived from another source? If yes, list source(s):

Recommended citation for this dataset:

DATA & FILE OVERVIEW

File List: <list all files (or folders, as appropriate for dataset organization) contained in the dataset, with a brief description>

Relationship between files, if important:

Additional related data collected that was not included in the current data package:

Are there multiple versions of the dataset? If yes, name of file(s) that was updated:

Why was the file updated?

When was the file updated?

METHODOLOGICAL INFORMATION

Description of methods used for collection/generation of data: <include links or references to publications or other documentation containing experimental design or protocols used in data collection>

Methods for processing the data: <describe how the submitted data were generated from the raw or collected data>

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Instrument- or software-specific information needed to interpret the data: <include full name and version of software, and any necessary packages or libraries needed to run scripts>

Standards and calibration information, if appropriate:

Environmental/experimental conditions:

Describe any quality-assurance procedures performed on the data:

People involved with sample collection, processing, analysis and/or submission:

DATA-SPECIFIC INFORMATION FOR: [FILENAME]

<repeat this section for each dataset, folder or file, as appropriate>

Number of variables:

Number of cases/rows:

Variable List: <list variable name(s), description(s), unit(s) and value labels as appropriate for each>

Missing data codes: <list code/symbol and definition>

Specialized formats or other abbreviations used:

Keywords:

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call
HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Annex VI – Data Availability Statement Examples

CASE	STATEMENT EXAMPLE
Data are openly available in a repository	"Data supporting this study are openly available from [NAME OF REPOSITORY] at [DOI, ACCESSION NUMBER OR URL]"
Data are available in a repository, but subject to an embargo	"Data supporting this study will be available from [NAME OF REPOSITORY] at [DOI, ACCESSION NUMBER OR URL] following a 6-month embargo"
Data are available in a repository, but access is restricted due to legal, ethical or commercial reasons	"Data supporting this study are available from [NAME OF REPOSITORY] at [DOI, ACCESSION NUMBER OR URL]. Access to the data is subject to approval and a data sharing agreement due to [GIVE REASONS WHY ACCESS TO THE DATA IS RESTRICTE]"
Secondary analysis of third-party data subject to restrictions	"This study used third party data made available under licence that the author does not have permission to share. Requests to access the data should be directed to [THIRD PARTY] at [URL/CONTACT DETAILS]"
Data available as supplementary information	"Data supporting this study are included within the article and/or supporting materials"
Data are available on request only due to ethical, legal or commercial reasons	"Data supporting this study are not publicly available due to [GIVE REASONS WHY DATA ARE NOT PUBLIC]. Please contact [GIVE EMAIL ADDRESS]"
Data cannot be shared due to ethical, legal or commercial restrictions	"Data supporting this study cannot be made available due to [GIVE REASONS WHY THE DATA CANNOT BE SHARED]"
No new data generated or analysed	"No new data were generated or analysed during this study"

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Annex VII –Scientific Publications List

No	PUBLICATION TITLE	JOURNAL	PUBLICATION DATE	JOURNAL TYPE*	OPEN ACCESS REPOSITORY	REPOSITORY PUBLISHING STATUS***
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Hybrid, Gold Open, Diamond Open; ** Creative Commons Licence Type (https://creativecommons.org/share-your-work/cclicenses/); * SM: Submitted Manuscript; AAM: Author Accepted Manuscript; VoR: Version of Record (published)*

Funded by the European Union
TwInn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570

Annex VIII –Data Management Bodies

Due to the protection of personal data, this Annex is different in the public version of the DMP.

GENERAL ASSEMBLY			
AFFILIATION	**PERSON**	**EMAIL**	**WORK ADDRESS**
NTUA	Evangelos Topakas		
IMGGE	Jasmina Nikodinovic-Runic		
TUS	Marija Nicevic		
UNIBA	Gennaro Agrimi		

INTELLECTUAL PROPERTY RIGHTS BOARD			
AFFILIATION	**PERSON**	**EMAIL**	**WORK ADDRESS**
NTUA	Aggelos Tsakanikas		
IMGGE	Jasmina Nikodinovic-Runic		
TUS	Margaret Brennan Fournet		
UNIBA	Isabella Pisano		

WORK PACKAGE LEADERS				
WP	**PARTNER**	**PERSON**	**EMAIL**	**WORK ADDRESS**
1	NTUA	Evangelos Topakas		
2	UNIBA	Gennaro Agrimi		
3	NTUA	Evangelos Topakas		
4	TUS	Marija Nicevic		
5	NTUA	Evangelos Topakas		
6	IMGGE	Jasmina Nikodinovic-Runic		

Funded by the European Union
Twinn4MicroUp is funded by the Horizon Europe call HORIZON-WIDERA-2023-ACCESS-02 under Grant Agreement No. 101159570