Circular Manufacturing 5.0: Human-Centred AI-aided Digital Framework for Closed-loop Photovoltaic (PV) products Value Chains

D1.4
Data Management Plan and Regulatory, Societal, Gender & Ethical Issues-V01

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Executive Summary

This is the first version of CIRCMAN5.0 Data Management Plan that describes how the data gathered and generated in the CIRMAN5.0 project will be managed, stored and used for different activities. This deliverable will be a live document and will be updated continually until the end of project to consider any changes in the data management and governance needs and procedures that may arise during the project. This deliverable reports the work carried out in the Task T1.4 "Data Management and Governance, Societal and Ethical Issues", which is primarily focused on monitoring the data generated by different project activities and ensuring these are in line with legislation such as the General Data Protection Regulation (GDPR), the Findable, Accessible, Interoperable and Reusable (FAIR) data principles, among others.

In essence, this deliverable provides a framework for data management and policies for fulfilling FAIR data principles. It also implements relevant legislations that apply in the context of the different tasks of the CIRCMAN5.0 project, such as GDPR for personal data. Moreover, the deliverable provides an assessment of the risks associated with the development and use of Artificial Intelligence (AI) systems in the project. The assessment has been performed based on the High-Level Expert Group (HLEG) on Artificial Intelligence guidelines for Trustworthy AI. Finally, the deliverable provides the results on a gender survey that has been carried out to ensure gender balance within the project. The analysis reported in this deliverable allows the project to put in place specific measures that ensure gender balance in the project.

1 Introduction

1.1 Purpose and scope of the deliverable

The objective of this deliverable is primarily to provide guidelines for the project partners to make their data findable, accessible, interoperable and reusable (FAIR) based on open research data requirements of Horizon Europe. In this respect, this deliverable summarises the data generated by various work package (WP1-WP7) with the aim to describe the techniques and procedures used in the project for data gathering, processing and its storage. The final version of this deliverable will be submitted in M36.

CIRCMAN5.0 will set up a Data Governance framework which will be based on security policies for data sharing in line with the FAIR data principles and EU's Digital Product Passport initiative. This will facilitate the transition of PV Manufacturing industry towards a circular economy, and provide an effective way of tracking, tracing, and certifying of materials, components and products.

This deliverable conducts an initial assessment on the data that will be handled by the pilot programs. As such, it constitutes a starting point for the data identification needed for T5.3. As this task (T5.3) is dedicated to facilitating harmonization with data spaces, knowledge of the current (and desired) status of the data is mandatory, as well as their data-space readiness. Therefore, a subsequent assessment will be performed, requesting specifics that influence data exchange and will be included in D5.2 (Data Spaces enablement).

1.2 Relation to other WPs and tasks

This deliverable covers most of the activities that will be carried out in the CIRCMAN5.0 project. WP2- "Requirements for Circularity in PV manufacturing" identifies the research data that will be gathered and generated in the project. This deliverable also helps with that activity to gather the data regarding pilot activities while also highlighting the purpose and utilization of the pilot data during the lifespan of the project. Technical partners involved in AI tasks from WP3, WP4 and WP5 have provided their input in this deliverable by performing self-assessment of AI developments based on the Ethical Guidelines for Trustworthy AI. On the other hands, the guidelines for data management and ethical AI development will be used by all technical partners developing advanced techniques and technological solutions in various tasks of the project. In addition, all partners have also provided their input to a gender survey which collects feedback and impressions about gender balance and related issues to be addressed in the project.

1.3 Structure of the deliverable

The document is divided into ten sections, each briefly described as follows:

- Section 1 describes the scope of this deliverable and relation of D1.4 to other WPs/tasks.
- Section 2 provides an initial summary of the data to be gathered, generated and managed in each work package of the project considering its need and utilization in different contexts.
- Section 3 defines the FAIR data principles and describes the requirements to fulfill FAIR data principles in the project.
- Section 4 describes the methods for storing other research outputs.
- Section 5 presents the resources allocated for data management in the project.
- Section 6 describes the data handling and governance procedures adopted in the CIRCMAN5.0 project.
- Section 7 presents the ethical and legal guidelines for data management. An awareness of these local and EU-level guidelines is considered important to ensure the compliance of project activities with the relevant guidelines and regulations, such as GDPR.
- Section 8 concludes this deliverable with directions for future work that will be reported in the next iteration of this deliverable in M36 of the CIRCMAN5.0 project.
- Section 9 presents provide the list of Acronyms used in this deliverable.
- Section 10 presents an Appendix that contains the questionnaire used for gathering the information reported in this deliverable.

2 CIRCMAN5.0 Data Summary

This section details the data to be gathered and handled in the project based on the different tasks and activities in each WP. Taking into account early stage of the project (M06), a brief description of the data is provided in the following subsections, such as the expected file formats, purpose, utility and the origin of the data. More detailed specifications of the data gathered, generated and managed in the project will be provided in the next version of this deliverable.

2.1 Internal Documents

The internal documents produced and used in the project are subject to the data management and governance guidelines defined in the project. A summary of the internal documents to be developed in the CIRCMAN5.0 project is presented in the following table:

Table 1. Data summary of internal documentation

Context	Nature of Documents
Description	Documents set-up and updated during the preparation and execution of the CIRCMAN5.0 project. These include the Consortium Agreement, Grant Agreement, document templates, working documents, the project deliverables, minutes of meetings, internal and external presentations of the project progress and its results. The set-up, management, editing and storage of CIRCMAN5.0 documents is done using SharePoint.
Purpose	Provision of all information to successfully perform the project tasks.
Formats	.docx, .pptx, .xlsx, .pdf, .txt
Origins	Project partners
Size	Typically < 20 MB
Utility	Depending on dissemination level
Storage	Project Sharepoint

2.2 Pilot Data

This section describes the pilot's datasets that will be collected and generated in the CIRCMAN5.0 project. The purpose of describing individual pilot data is to collect information about source, ownership, security requirements, regulatory constraints and adherence to FAIR data principles. This information will be used to identify relevant data management and governance guidelines that can be applied in technical developments and other project activities.

2.2.1 Pilot 1: Alternative raw materials identification and evaluation for sustainable-by-design BIPVs – [Main Focus Phase: Product Design] (ONYX)

The main goal of ONYX pilot in the CIRCMAN5.0 Project is to be able to identify new materials usable in the PV manufacturing process, with a higher percentage of recyclability and a more sustainable End of Life (EoL). To achieve this, a 4-steps target process is designed to be followed in order to support the research, experimentation and validation activities in the CIRCMAN5.0 project:

1. Identification of PV module's components which can be taken apart so that they can be reused. AI-driven Parametric techniques and LCA-based methods will be used for that purpose.
2. Analysis of material suppliers which can provide solutions with a greater percentage of recyclability.
3. Integration of such materials into ONYX's manufacturing process. ML-assisted Production Planning is intended to provide recommendations for production reconfiguration and reallocation.
4. Evaluation of the new final product will be performed through Defect Detection models.

Data Title:	Raw materials, resource needs and costs for product design and manufacturing.
Data ID	N/A
Description:	All the data shared by ONYX will be directly related to its product design and manufacturing process: raw materials used, resource needs, personal costs and any other.
Owner:	ONYX SOLAR ENERGY S.L.
Data Source (device, cloud, system etc.)	ONYX's production line.
Data access, sharing and licensing	Datasets will be shared via the MS Teams environment and e-mail.
Class (IPR – open, private, confidential)	Private. Accessible to involved consortium partners.
Data type (Integer, Float, String etc.):	To be determined depending on the specific data requested.
Data format (JSON, CSV, TXT etc.):	Mainly MS Excel, Word and PPTX files. Other data types could be used if required.
Access Protocol:	Data will be directly shared via email or uploaded to MS environment.
Data size:	Each dataset is expected to be typically under 20 MB in size.
Data storage/Repository:	Data will be stored in ONYX internal server.
Personal information:	N/A – no personal information will be included in the shared datasets

Data Security Needs (e.g. data needs to be anonymized, or encrypted or not shared outside the project etc.):	Data cannot be shared outside the project.
Regulatory Constraint Requirements (e.g. not stored outside EU or acquisition of consent):	To be determined.
Are you reusing the data or is the data reuseable? If YES, which data and how?	Yes.
Data preservation period (is there an expiry date for the data?):	No.
How long will the data remain available and findable? Will metadata be guaranteed to remain available after data is no longer available?	Data will be available at any time. No metadata will be created.
Describe Unique and persistent identifier (e.g., DOI, URI)?	To be determined.
Describe what type of rich metadata is used (e.g., title, creator, keywords)?	N/A
Is the data quality and reliability assessed and documented (e.g., validation, provenance)? If yes, how?	ONYX products and data related provided are certified under ISO 14001 and ISO 9001.
Is the data interoperable? If yes, mention the usage of any standard vocabularies/data models/ontologies	To be determined.

2.2.2 Pilot 2: c-Si BAPVs and BIPV production line environmental assessment and circular digital registry development– [Main focus phase: Production Planning and Manufacturing] (SUNAGE)

SUNAGE, as an industrial partner of the consortium, will focus on the following topics:

- Discover from the design phase of the products, the possible alternatives in the material selection phase and in the production process phase to gather more sustainable PV panels
- Extend the circular approach in the PV production processes
- Develop the DPP of SUNAGE product and verify compliance with the guidelines of the Environmental Product Declaration (EPD)

These targets will be reached by exploiting the tools developed in the CIRCMAN 5.0 project, in particular:

- The use of AI-driven Parametric techniques for product eco-design will provide alternative solutions and designs for the company's PV modules taking into account parameters that will reduce their environmental footprint throughout their life cycle and beyond.
- Through the Collaborative Space (expected to involve OEMs, product/material suppliers, providers, recycling companies, etc.) will be able to find new suppliers

capable of fulfilling the needs of the company in a shorter time and with a lower environmental impact.

- Using the ML-assisted Production Planning together with the Cognitive Digital Twin simulated environment to find a set of instructions capable to reduce energy consumption, CO2 emissions and resources use in all stages of manufacturing process.
- The energy-related parameters will be measured and evaluated through the Circular and LCA Framework which will include the measurements from the LCA-based Methods for embodied energy and embodied carbon footprint.

Data Title:	EPD data for LCA, manufacturing/design data, raw materials data
Data ID	N/A
Description:	All the data shared by SUNAGE will be directly related to its product design and manufacturing process
Owner:	SUNAGE SA
Data Source (device, cloud, system etc.)	SUNAGE internal database
Data access, sharing and licensing	Data will be shared via the MS Teams environment and e-mail.
Class (IPR – open, private, confidential)	Private. Accessible **only** to involved consortium partners.
Data type (Integer, Float, String etc.):	To be determined depending on the specific data requested.
Data format (JSON, CSV, TXT etc.):	Mainly MS Excel, Other data types could be used if required.
Access Protocol:	Data will be directly shared via email or uploaded to MS environment.
Data size:	<100 MB
Data storage/Repository:	Data will be stored in SUNAGE internal server.
Personal information:	N/A
Data Security Needs (e.g. data needs to be anonymized, or encrypted or not shared outside the project etc.):	Data cannot be shared outside the project. Data cannot be shared with partners inside the project not involved with SUNAGE tasks.
Regulatory Constraint Requirements (e.g. not stored outside EU or acquisition of consent):	To be determined.
Are you reusing the data or is the data reuseable? If YES, which data and how?	Yes.
Data preservation period (is there an expiry date for the data?):	No.
How long will the data remain available and findable? Will metadata be	Data will be deleted at the end of the project. No metadata will be created.

guaranteed to remain available after data is no longer available?	
Describe Unique and persistent identifier (e.g., DOI, URI)?	To be determined.
Describe what type of rich metadata is used (e.g., title, creator, keywords)?	N/A
Is the data quality and reliability assessed and documented (e.g., validation, provenance)? If yes, how?	SUNAGE products and related data are certified under ISO 14.001 and ISO 9.001.
Is the data interoperable? If yes, mention the usage of any standard vocabularies/data models/ontologies	To be determined.

2.2.3 Pilot 3: Organic PVs circular design alternatives for EoL disassembly and AI-aided production process EIA – [Main focus phase: Product design and Manufacturing] (ASCA)

ASCA's project seeks to establish a baseline for the current organic photovoltaics (OPV) design and manufacturing process, comprised of raw-material- and product- footprints, resource efficiency/waste, energy consumption, CO2 emissions, duration of workflows, use of labor, recyclability, etc. The primary objectives are the improvement and optimization of the design and manufacturing aspects with an aim to increase sustainability and circularity in its OPV manufacturing.

This could be achieved for example by the following measures:

1. Improvement of OPV design process
    a. Use of materials with lower environmental impact during manufacturing
    b. Use of materials made from recycled materials
    c. Use of recyclable materials
    d. Challenges
        i. up to 50% speciality chemistry
        ii. Thorough testing and optimization efforts
        iii. Manage performance, stability and cost
    e. Upgrade of layouting software and tools
        i. Increase degree of automation
        ii. AI and machine learning support
2. Improvement of product manufacturing
    a. Process optimization
        i. Reducematerial usage
        ii. Increase production speed
        iii. Reduce energy consumption
        iv. Make a more effective use of surface area (gFF)
    b. Higher degree of automation
        i. Throughput increase
        ii. Reduction of waste/rejects
    c. Optimization of production planning

i. Effective management of manpower
ii. Better alignment of individual process steps
iii. Minimization of waste

d. New/improved quality control procedures
   i. Early detection of rejects
   ii. Better reliability & product quality
e. Digitalization and virtualization through digital twins

Data Title:	**Raw material/supplier, design, production process and LCA data**
Data ID	N/A
Description:	All the data shared by ASCA will be directly related to its raw materials, product design and manufacturing process.
Owner:	ASCA GmbH & Co. KG
Data Source (device, cloud, system etc.)	ASCA internal database
Data access, sharing and licensing	Data will be shared via the CIRCMAN5.0 exchange platforms and via email.
Class (IPR – open, private, confidential)	Private. Accessible to involved consortium partners only.
Data type (Integer, Float, String etc.):	To be determined depending on the specific data requested.
Data format (JSON, CSV, TXT etc.):	Mainly Excel or txt files. Other data types could be used if required.
Access Protocol:	Data will be directly shared via email or uploaded to the CIRCMAN5.0 exchange platforms.
Data size:	Typically < 20 MB.
Data storage/Repository:	Data will be stored on ASCA internal server.
Personal information:	N/A
Data Security Needs (e.g. data needs to be anonymized, or encrypted or not shared outside the project etc.):	Data cannot be shared outside the project. Data cannot be shared with partners inside the project not involved with ASCA tasks.
Regulatory Constraint Requirements (e.g. not stored outside EU or acquisition of consent):	To be determined.
Are you reusing the data or is the data reuseable? If YES, which data and how?	Yes
Data preservation period (is there an expiry date for the data?):	No
How long will the data remain available and findable? Will metadata be guaranteed to remain available after data is no longer available?	Data will be available at any time, but will not be accessible to partners after the end of the CIRCMAN5.0 project. No metadata will be created.

Describe Unique and persistent identifier (e.g., DOI, URI)?	To be determined
Describe what type of rich metadata is used (e.g., title, creator, keywords)?	N/A
Is the data quality and reliability assessed and documented (e.g., validation, provenance)? If yes, how?	According to ASCA internal quality control procedures
Is the data interoperable? If yes, mention the usage of any standard vocabularies/data models/ontologies	To be determined

2.2.4 Pilot 4: Optimal R-strategies for EoL multi-PV typologies – [Main focus phase: EoL] (SOLITEK)

The primary motive for SOLITEK pilot is to improve its products' recyclability & re-usability, specifically glass-glass bifacial PV modules. Additionally, SOLITEK aims to consider LCA, recyclability & re-usability of the following solutions: PVT, tandem mini-modules, encapsulation-free module.

To achieve it the following objectives are set:

1. To evaluate suppliers for components with higher & of recycled content.
2. Calculation of LCA & EPD (EN 15804 +A2) for glass-glass bifacial PV modules. Consider the changes in LCA when components or materials are modified for alternative solutions, such as PVT, tandem mini-modules, or encapsulation-free PV modules.
3. To include recycling and re-use guidelines into digital product passports (DPP)To develop processes for SOLITEK to test EoL PV modules for re-use.

Data Title:	**LCA data, production processes data, suppliers data.**
Data ID	**N/A**
Description:	Data shared by SOLITEK will be directly related to its products design and manufacturing process: raw materials used, energy consumption, suppliers data & their LCA inputs.
Owner:	**SOLITEK**
Data Source (device, cloud, system etc.)	**Cloud & internal database.**
Data access, sharing and licensing	Data will be shared via the MS Teams environment and e-mail.
Class (IPR – open, private, confidential)	**Private. Accessible to consortium partners.**
Data type (Integer, Float, String etc.):	To be determined depending on the specific data requested.

Data format (JSON, CSV, TXT etc.):	Mainly MS Excel, Word and PPTX files. Other data types could be used if required.
Access Protocol:	Data will be directly shared via email or uploaded to MS environment.
Data size:	<20mb
Data storage/Repository:	Within SOLITEK internal database
Personal information:	N/A
Data Security Needs (e.g. data needs to be anonymized, or encrypted or not shared outside the project etc.):	Data cannot be shared outside the project.
Regulatory Constraint Requirements (e.g. not stored outside EU or acquisition of consent):	To be determined.
Are you reusing the data or is the data reuseable? If YES, which data and how?	No.
Data preservation period (is there an expiry date for the data?):	No
How long will the data remain available and findable? Will metadata be guaranteed to remain available after data is no longer available?	Data will be available at any time. No metadata will be created.
Describe Unique and persistent identifier (e.g., DOI, URI)?	To be determined.
Describe what type of rich metadata is used (e.g., title, creator, keywords)?	N/A.
Is the data quality and reliability assessed and documented (e.g., validation, provenance)? If yes, how?	Based on ISO 14.001 and ISO 9.001.
Is the data interoperable? If yes, mention the usage of any standard vocabularies/data models/ontologies	To be determined.

2.2.5 Observed commonalities from the pilot data

An overarching commonality from sections 2.2.1 to 2.2.4 is that there are a number of fields that have not been decided upon at the time of writing this document. On the other hand, all pilot leaders do describe their MS Teams environment and e-mail as default avenues for sharing data. The data exchange channels are going to be streamlined so that the data can be safely exchanged, with automation wherever possible, and subsequently interpreted by partners. The pilot owners cite as well the MS Office formats (docx, xslx, pptx) as their initial go-to alternatives, although they do leave the door open for other formats as required. In the same vein, considerations related to the use of standardized data models are at the moment absent from responses to questions about unique identifiers, metadata, data interoperability.

All pilots required that their data not be shared outside the scope of the project. This may have to be reconsidered while working on Tasks T5.3 and T5.4, which by nature involve data exchanges, and especially for tasks involving DPP implementations, as the technology is meant to register the evolution of a product throughout its production stages.

2.3 Generated Data

Data generated by technical work packages (WP2-WP6) is described in this subsection.

Table 2. *Data Summary of Use-case Requirements (WP2)*

Context	Use-case Requirements for Circularity in PV Manufacturing
Description	The corresponding WP2 deliverables that will describe the data and specifications of the CIRCMAN5.0 solutions are: • D2.2: User requirements, Specifications of CRIRCMAN5.0 (Version 1, Version 2, Version 3) • D2.3: Use Cases Definition (Version 1, Version 2)
Purpose	Defining requirements for end-users, designing CIRCMAN5.0 reference architecture and the needs, mapping and definition of each use case.
Formats	Main files that will be used are: .docx, .xlsx, .pdf, .zip
Origins	Use case project partners and technical partners/providers
Size	Typically < 10 MB
Utility	Technical partners, AI model developers and use case partners for pilot demonstration
Storage	Can be stored locally and be accessible through the CIRCMAN5.0 shared folder.

Table 3. Data Summary of Simulation and Modelling Software for process and product manufacturing (WP3)

Context	Simulation and Modelling Software
Description	Basic documentation for the libraries developed for the simulation and modelling solution will be made available in line with the consortium agreement, short instructions, and code examples
Purpose	Interaction with the project partners co-responsible for use cases.
Formats	.docx, .pptx, .txt, .pdf, .zip
Origins	Project partners
Size	Typically < 1 GB
Utility	AI model developers and use case partners
Storage	Simulation and modelling software results will be accessible through the CIRCMAN5.0 shared folder

Table 4. Data summary of CIRCMAN5.0 toolbox for Environmental Impact Assessment (WP4)

Context	Environmental Impact Assessment
Description	Documentation related to assessment of carbon, supply chain circularity, eco-footprints and AI models for environmental impact assessment.
Purpose	To perform impact assessment through CIRCMAN5.0 toolbox.
Formats	Mainly MS Excel to train predictive AI models. Other data types could be used if required.
Origins	Project partners
Size	Typically < 1 GB
Utility	Partners involved in the related tools development
Storage	Simulation and modelling software results will be accessible through the CIRCMAN5.0 shared folder.

Table 5. Data summary for T4.1 activities

Context	Environmental Impact relevant KPIs
Description	Documentation related to embodied energy and carbon footprint for the innovative CIRCMAN 5.0 PV technologies
Purpose	Environmental KPIs throughout the main three PVs lifecycle (i.e. manufacturing, operation and end-of-life)
Formats	.docx, .xls
Origins	Relevant LCIs from i) PVs technology providers and ii) recognized databases (e.g. Ecoinvent)
Size	Typically < 5 MB
Utility	Partners involved in the related tools development and technology providers. The results can be shared also with the demo site owners
Storage	Can be stored locally and can render accessible through the CIRCMAN5.0 shared folder.

Table 6. Digital Product Passport Platform for Circular Data Spaces (WP5)

Context	Digital Product Passport Platform
Description	Documentation related to development of blockchain-based mechanisms for digital tracing and certification of materials in the value chains
Purpose	To develop digital product passport platform
Formats	Web application, db data, csv,.docx, .pptx, .pdf, .zip
Origins	CERTH with the collaboration of project partners
Size	Typically < 1 GB
Utility	Technical partners and end users (depending on the use case scenario)
Storage	The tools can be installed locally, on cloud, or mixed solution

Table 7. Integration, Validation and Pilot Demonstration (WP6)

Context	Integration, Validation and Pilot Demonstration
Description	The purpose of this work package is to develop, integrate, and validate the CIRCMAN5.0 digital tools through real-world pilot implementations, ensuring end-user engagement, co-creation, and training to support circular manufacturing in the PV sector.
Purpose	Develop, integrate and validate the CIRCMAN5.0's digital toolbox.
Formats	Web application, mdf (sql), csv,.docx, .pptx, .pdf, .zip
Origins	RINA with project partners collaboration
Size	Typically < 1 GB plus stored data
Utility	Technical partners and end users
Storage	The tools can be installed locally, on cloud, or mixed solution

Table 8. Data summary of dissemination materials (WP7)

Context	Dissemination and promotion material
Description	Dissemination material generated and provided by the CIRCMAN5.0 consortium includes presentations, contributions and publications at domain-specific conferences and journals, as well as research data not subject to IPR or data privacy.
Purpose	To raise awareness of the project and foster community engagement.
Formats	.docx, .pptx, .xlsx, .csv, .pdf, .zip .mp4
Origins	Project partners
Size	Typically < 100 MB
Utility	Public, CIRCMAN5.0 partners and the EC.
Storage	Sharepoint

3 FAIR Data Principles

3.1 Findable:

To ensure findability of data, CIRCMAN5.0 will publish datasets (generated and used in the project) in a public and open Zenodo data repository, which is already setup and can be accessed through this link:

https://zenodo.org/communities/circman5/records?q=&l=list&p=1&s=10&sort=newest

Zenodo assigns unique DOIs ensuring that the data is findable. A standardized naming convention (for instance, complaint with ISO/IEC 11179-5:2015[1]) for the CIRCMAN5.0 project will be used. Moreover, identifiers such as ORCID [2] will be used to identify contributors and DataCite[3] will be used for identification of data.

3.2 Accessible:

CIRCMAN5.0 will follow Open Access to Scientific Publications & Open Access to Research Data in Horizon Europe. Research data will be stored in open access and non-proprietary repositories and non-proprietary indexing based on a standardized communication protocol. CIRCMAN5.0 will implement authentication and authorization techniques for accessing the datasets that are private or confidential. After proper anonymization for confidential data, the dataset will be accessible and information about the data/metadata will remain available.

Dissemination of project results will follow an open-access policy which applies to all scientific and peer-reviewed publications generated through the project. It will be made freely available via an online repository and on the project website. All the project related presentations, publications and contributions should include the project logo (following journal requirements) and the related meta data such as grant agreement number and name of the project etc.

Also, to support coherent software development, CIRCMAN5.0 will use Git version control system for maintaining the software versioning of the tools that are developed within the project. Each component will be self-contained, and different branches will be used to define the various functionalities. A survey will be carried out in Task 7.2 (Exploitation Strategies and Standardization Efforts) to identify the technical components that are not covered by intellectual property rights (IPR). These tools will be released as open-source software components and will be openly distributed through Zenodo along with pointers to source code in GitHub repository where applicable.

3.3 Interoperable:

Interoperability refers to the ability of different IT systems to exchange, understand, and use data effectively, enabling communication and collaboration between them. The European Interoperability framework identifies four interoperability layers, namely Technical, Semantic, Organizational and Legal. The technical tasks in the CIRCMAN5.0 project will adopt commonly used vocabularies and ontologies based on a well-defined data model such as Resource Description Framework (RDF) for knowledge representation to describe the structure of

[1] https://www.iso.org/standard/60341.html
[2] https://orcid.org/
[3] https://datacite.org/

metadata. To facilitate a standard approach towards interoperability, the task T5.3 (Integration with European Manufacturing Data Spaces) in the CIRCMAN5.0 project will investigate the status of the other interoperability frameworks and provide guidelines towards secure data sharing in different European data spaces.

3.4 Reusable:

CIRCMAN5.0 will aim to produce and share multiple open datasets to support research and development in the digital manufacturing and circular economy domains. The datasets produced in the CIRCMAN5.0 project will have clear and accessible data usage license, also providing provenance information such as the purpose and owner of the data collected/generated and defining its context. A README file will be created to ensure that the data is correctly interpreted and can be analyzed by others. Project will use the Creative Commons licenses[4], Attribution (CC BY) license and Creative Commons Zero (CC0) to allow 3rd parties to mine, exploit and reproduce the data.

Special attention should be paid to data storage methods relating to access and the interfaces that will be used to communicate with the databases and search engines. Data storage should be secure by applying appropriate encryption in the servers used for the pilot sites or by technology providers.

4 Other Research Outputs

The approach for sharing other research outputs such as software and algorithms, training and educational materials, visualizations and simulations, repositories etc. will be agreed upon with consortium partners in each development stage of the project. It is difficult to specify the right tool for such heterogenous nature of research outputs at this early stage of the project. For this reason, the next version of this deliverable will provide the details of the tools and techniques used for sharing research outputs in the project. It is expected that the project will adopt some commonly used tools such as GitHub, Zenodo, project website and EU repositories.

However, the data generated from pilot activities including measurements of vibrations, temperature, humidity in various formats (numerical data, texts, images and tables) will be deposited in a trusted open data repository such as Zenodo which ensures the findability by assigning Digital Object Identifiers (DOIs). This data release is subject to the pilot's approval.

5 Allocation of Resources

Data management in the CIRCMAN5.0 project will be carried out through relevant tools such as Microsoft teams and Sharepoint which provide the required level of fairness for data sharing, privacy and adherence to security standards. The project coordinator CERTH has set up a data management system for the storage of project-related documentation in SharePoint. Managing project related data is the collective effort of all partners and the project coordinator (CERTH) is leading the activities of establishing proper procedures for utilization of available resources for the project.

[4] https://creativecommons.org/share-your-work/cclicenses/

Data that is introduced by the partners in the project, hence classified as data owners, has the responsibility of managing the data by following relevant procedures based on Horizon guidelines. The data is only used for research and development purposes as well as demonstration activities that are performed within the scope of the CIRCMAN5.0 following data minimization principles.

Processing of personal data will take place after obtaining prior confirmation from the data subject to ensure that the beneficiary has a lawful basis for personal data processing. Appropriate technical and organizational measures in accordance with GDPR will be followed to protect the rights of data subject.

6 Data Handling

All the personal data in the project will be handled closely following GDPR[5] guidelines which enforce a set of data protection regulations for all individuals, business and organizations that use personal data of EU residents. The aim is to protect individuals' fundamental rights to privacy and protect their personal data. In CIRCMAN5.0, personal data processing will be processed only if at least one of the following conditions is satisfied:

- Informed consent has been granted by the data subject.
- The data subject is party to the performance of a contract, or the data subject has requested the necessary processing.
- The data controller must perform the necessary data processing to comply with a legal obligation.
- Data needs to be processed to protect the vital interest of the data subject.
- Data needs to be processed to complete a task for the public interest or to exercise the official authority granted to the controller.
- Data needs to be processed to follow the legitimate interests of the controller or a third party except when these interests are overridden by the right of data subject especially involving cases where the data subject is a child and data protection is mandatory.

The data subject will have the right, under the GDPR, to access the information regarding collection, purpose and use of their data. Data subjects have the authority to correct and delete their data and can object to its processing.

GDPR also imposes a functional requirement on personal data processing and analyzing for the data controllers and processors to implement appropriate measures based on the security principle. These measures (technical and organizational) also include data security using pseudonymization and encryption tools[6]. It is the responsibility of the data controller to notify the supervisory authority within 72 hours of a data breach when there is a risk to the data

[5] https://gdpr-info.eu/

[6] Art. 32(1)(a) GDPR.

subjects[7]. Such data breaches must be documented by the data controller describing the cause, consequences and the mitigation actions taken[8].

The following provisions for personal-data security should be followed by all CIRCMAN5.0 partners:

- The processing of personal data should be limited to the necessary use for achieving a particular objective unless explicit written consent is obtained from the data subject in accordance with the data minimization principle[9].
- Privacy and data protection requirements should be integrated into the design of the systems being developed in the project in accordance with privacy by design and default[10].
- The controller should assess the impact of processing operations on the protection of personal data to align with data protection impact assessments (DPIA) requirement[11].

6.1 Data Storage:

It is the responsibility of the project partners to ensure that data collected during different activities in the project is stored in servers that lie under their control and supervision. In case third party services are hired, the contracts should specify the equivalent level of security and compliance with relevant regulations.

A proper data backup policy must also be set up to periodically backup the data and should involve responsible personnel in charge of this task. It is also recommended to conduct periodic test evaluations.

6.2 Data Security:

It is the responsibility of the project partners to rely on privacy-preserving strategies for data storage to protect sensitive information. CIRCMAN5.0 will implement the following measures to maintain data security:

- Operating systems with strong authentication and access control are used.
- Network security polices and procedure are followed
- All electronic files are password protected where applicable.
- Local storage and databases are encrypted.

Each partner will take responsibility for managing their own access control and keeping the Project Coordinator (PC) informed about any change in security or access policy that affects other CIRCMAN5.0 partners.

[7] The GDPR defines a "personal data breach" in Article 4(12) as: a breach of security leading to the accidental or unlawful destruction, loss, alteration, unauthorized disclosure of, or access to, personal data transmitted, stored or otherwise processed."
[8] Article 33 GDPR
[9] Article 5(1)(c) GDPR. See also Lynskey, O., The Foundations of EU Data Protection Law (Oxford University Press, 2015), p. 206.
[10] Article 25 GDPR.
[11] Article 35 GDPR.

Each partner is responsible for the backup security and integrity of the datasets introduced in the project. The schedule of the data backup for pilots' data and project data should be decided in advance. The backup and the data storage during the course of the project should be secured applying appropriate encryption techniques. The data recovery plan must be setup to restore the project's data in case of data corruption, system damage and loss. Project partners must ensure that the transfer of sensitive data is encrypted using Open Secure Shell (OpenSSH) and Transport Layer Security (TLS).

7 Ethical and Legal Aspect

7.1 Ethical Dimension

CIRCMAN5.0 will follow all the technical and legal requirements listed below for data collection and use including personal data. The following are the main parameters considered for ethics compliance specifically concerning the handling of personal data:

- Processing of data that involves humans for the purpose of co-design, co-creation and evaluation will follow all the measures and safeguards to be in full legal and ethical compliance.
- GDPR and other relevant legal acts will be followed for personal data processing.
- AI systems will be developed using the guidelines from AI-High-Level Expert Group (AI HLEG).
- Adherence to the EU-HLEG on AI's 2020 Assessment List for Trustworthy AI (ALTAI).
- Follow and ensure compliance with the Data act[12] and the Artificial Intelligence Act[13] legislation.

CIRCMAN5.0 has already set up an Ethics Manager responsible to ensure that the project follows the ethical, privacy, regulatory and legal requirements.

7.1.1 Gender Dimension: Gender Analysis and Survey

The European commission has published its vision for gender inequality in a document "A Union of Equality: Gender Quality Strategy 2020-2025"[14]. Its purpose is to build a fairer, more inclusive and gender-equal society. CIRCMAN5.0 takes into account these guidelines and has conducted a gender-oriented survey to capture some initial feedback on gender related issues from the consortium partners. Gender analysis data is collected in Table 9 to gather statistics of researchers and non-researchers working in the project. This analysis is carried out to give priority to intersectional equality during the pilot use cases and validation of results (WP6) and meet the specific needs of each gender according to "Horizon Europe" requirements.

[12] https://www.eu-data-act.com/
[13] https://artificialintelligenceact.eu/
[14] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0152

Partner	Total Number of Researchers on the project		Total Number of Non-Researchers on the project		Total number of staff on the project	
	Male	Female	Male	Female	Male	Female
CERTH	13	3	1	1	14	4
ICCS	4	0	4	0	4	0
UIO	6	0	0	1	6	1
POLIMI	3	5	0	0	3	5
SUPSI	1	1	2	1	3	2
IFE	1	1	1	1	2	2
CETMA	2	0	3	0	5	0
EXUS	4	2	4	4	8	6
TTS	3	0	1	0	4	0
XGL	1	1	1	0	2	1
RINA	4	1	2	3	6	4
INNO	2	2	0	0	2	2
JGEA	1	4	0	0	1	4
I4bd	1	0	1	0	2	0
GDDS	1	1	0	0	1	1
ONYX	0	0	2	3	2	3

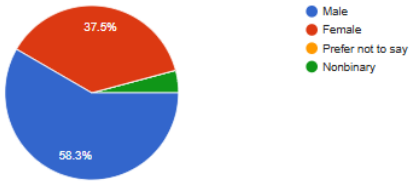
SUNAGE	0	0	2	4	7	2
ASCA	3	1	0	0	3	1
SOLITEK	2	0	1	1	3	2
Total	52	22	25	19	78	38

Table 9. Gender Statistics

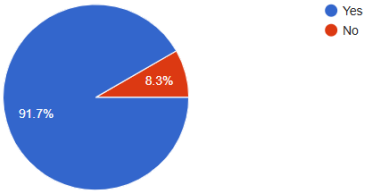
A gender survey questionnaire prepared by XGL using Google Forms has been shared with and is completed by all project partners. It captured the response anonymously and its analysis is presented below:

Total Responses Received: 24

1. What is your gender?



2. Have you worked on any European project before?



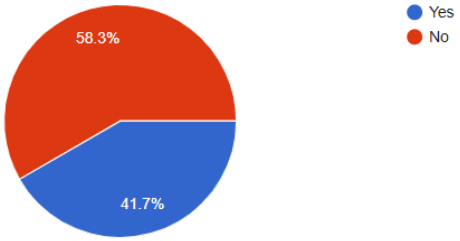
3. If yes, have any of the projects dealt with any gender-related issues e.g. collected gender statistics, informed about gender-related policies, considered creating a gender equality plan etc.? Please elaborate

Summary of response:

80% of the project partners responded that the European projects that they worked on considered gender related statistics and addressed gender issues to promote gender equality. Moreover, the partners also specified that none of the activities within these projects contributes to gender inequalities. There is also a specific emphasis on "gender innovations" by ensuring that the technology is intuitive and easy to use for both genders.

4. What is your background?

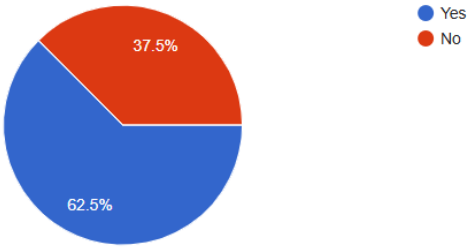
5. Are you aware of any gender-related policies by the European Commission e.g. the EC Gender Equality Strategy?



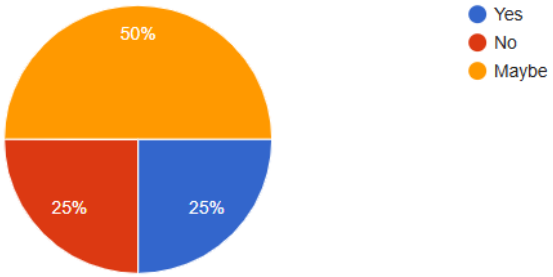
6. If yes, please elaborate

Summary of responses: Only 20% are aware of EU Gender Equality Strategy 2020–2025.

7. If no, would you be interested to be informed about this?



8. Do you think it is important that we discuss gender-related topics on the CIRCMAN5.0 project?

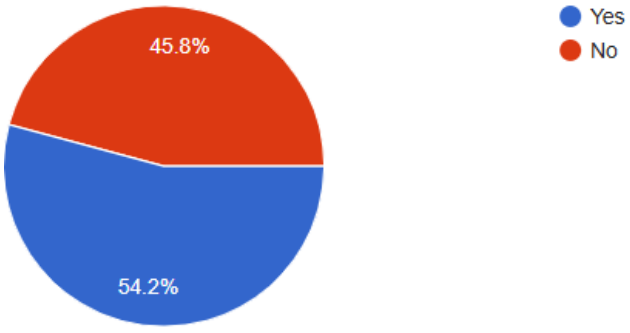


9. If yes, please suggest any actions that we should take on the project in order to increase awareness about and address any gender inequality, discrimination or intimidation.

Summary of response: Suggestions that came from consortium partners are listed below:

- Organization of workshops to deal with the topic. Communication actions for students (even high school) focused on promoting gender equality with specific examples in CIRCMAN5.0 (e.g. role of female researchers/managers)
- Supporting initiatives that encourage gender balance in corporate and political leadership. For example, the Women on Boards Directive (2022) mandates gender quotas in company leadership positions
- Set measurable goals related to gender equity, such as a specific percentage of women in leadership roles or project teams, or regular training participation rates.
- For instance, to encourage the use of inclusive language that avoids stereotypes or gendered assumptions, to foster gender-diverse teams within this project
- I would encourage relevant partners to present something on gender equality for this project to the consortium.

10. Are you aware of any policy documents that exist in your company aiming to address gender inequality and improve gender balance?

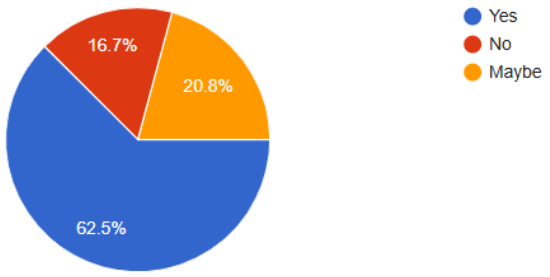


11. If yes, please elaborate what these documents are and how they have been provided to you.

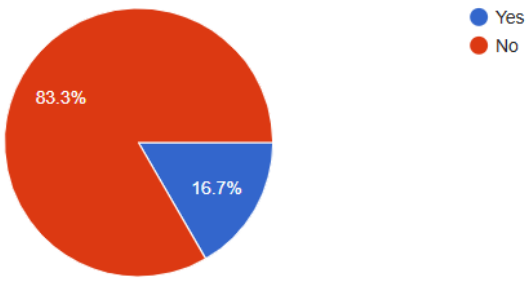
Responses:

- Gender Equality Plan through my Institution
- Part of the company philosophy. No specific documents are available.
- We have constructed an elaborate Gender Equality Plan, based on EU guidelines and everyday experience. Of course, we keep the document updated and we are trying to collaborate with external partners in order to expand our understanding in work culture and promote those ideas through workshops to other companies in our ecosystem.
- There are internal policies available on the intranet, but not a GEP
- The communication department deployed a periodic report about KPI in gender equity and drew up guidelines for the next period.
- It is a Gender Equality Plan which contains general information about the regulatory framework, statistics with number/figures, the methodology followed, etc. It is a public document.
- Documents can be downloaded from the company's intranet
- They are important during project development phases.

12. If no, do you think that it would be good for your organization to have such documents and provide them to their employees?



13. Have you ever had any adverse gender-related personal experience in your organisation?



14. If yes, what were the actions taken in response to this?

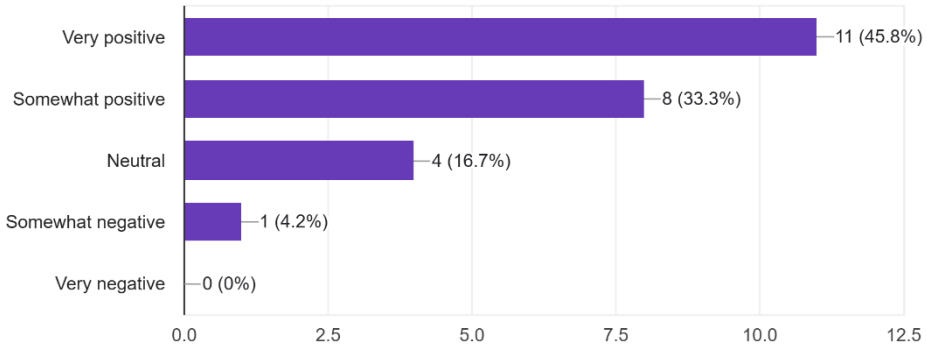
Summary of responses: No specific or satisfactory actions were taken

15. Please write any further comments/suggestions you wish to make on this topic.

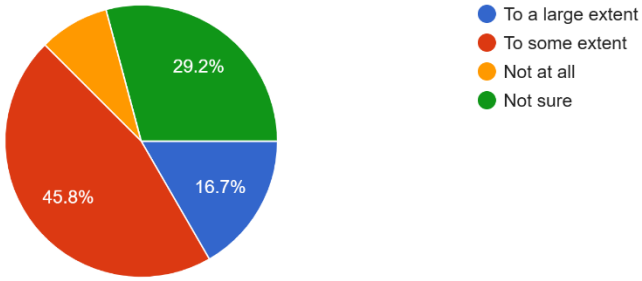
Responses:

- There might be several definitions and perceptions of "gender quality". It would be interesting to know more about this in the context of the project (or in general)
- Maybe a coordinated seminar in the aforementioned issues and the importance of women in STEM.
- there is still a huge gap between policies and reality
- Having an official document that addresses the issue makes the possibility of overcoming the problem more real.
- Specific activities should be considered in the framework of the project (workshops, D&C)
- First of all, as new technologies become central to circular manufacturing, there's a need to prioritize inclusivity in their design phase. Inclusivity should be built into the design of automation tools, AI systems, safety protocols, and remote work solutions.
- Also, collaborating with universities, research centers, competence centers, and community organizations can help address intersectional challenges by expanding access to relevant skills and employment opportunities. Finally, the establishment of metrics to assess diversity, equity, and inclusion can help companies track progress and address areas that need improvement. Regular surveys, feedback loops, and data collection can provide valuable insights into how different groups are experiencing workplace changes and whether additional support or adjustments are needed.
- Embedding gender inclusivity practices into CIRCMAN5.0 will strengthen team cohesion, encourage innovation, and build a project that is not only successful but also widely respected.
- There are some interesting effects of working with gender equality that goes beyond the percentage of men and women in the projects or employed in the organization.
- increase awareness for gender equality in all organizations.
- I would seriously oppose any company initiatives probing into their employees lives outside the work environment, as it is not their concern.

16. How do you feel about the potential impact of new technologies in the circular manufacturing sector on your work environment?



17. Please elaborate
    Responses:
    - New technologies represent an opportunity for growing
    - The potential impact of new technologies in the circular manufacturing sector on the broader work environment is fascinating and highly promising, especially given how these technologies could reshape both sustainable practices and operational efficiencies in various industries.
    - My work environment has not been directly affected by circular manufacturing, as we are a technology provider. But circular manufacturing can promote diversity by creating new roles which contribute to a more inclusive workplace
    - They would not affect my work environment
18. To what extent do you believe that the proposed technologies in the CIRCMAN5.0 project will benefit employees of different genders equally?



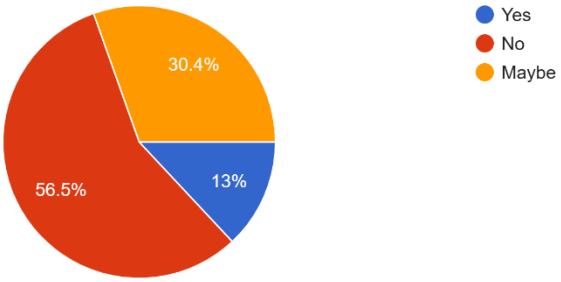
19. Please elaborate

Responses:

- Digital technologies have the potential for reducing gender gap
- CIRCMAN5.0 focuses on creating roles that merge human skills with digital and automated technologies. By offering reskilling programs, the project can potentially help all genders transition into these new roles, which could break down traditional gender-based job segregation in sectors like manufacturing and engineering, where men have historically been overrepresented

- CIRCMAN5.0 promotes health and wellbeing, comfort, and environmental quality within the manufacturing site environment considering gender aspects.
- Circular manufacturing is a cause that everyone can get behind and it can gather contributions from a wide range of perspectives but has no direct relation to gender issues.

20. In your opinion, are there specific needs or challenges that certain genders might face with the adoption of new technologies focused on circular manufacturing?

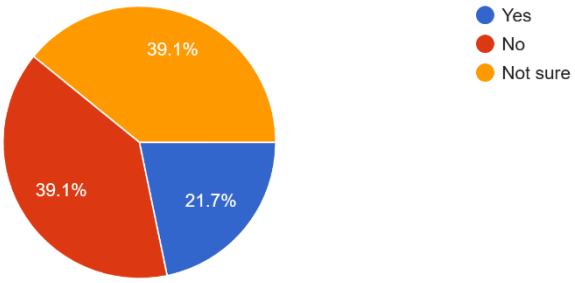


21. Please elaborate

Responses:

- I suggest organizing a dedicated workshop (even 1-2 hours) maybe during a GA to discuss it
- The adoption of new technologies in circular manufacturing has tremendous potential to benefit everyone, but addressing the unique challenges faced by different genders is crucial to realizing this potential fully. By prioritizing inclusive training, flexible work policies, bias-free technology, and diverse leadership, the circular manufacturing sector can be made more accessible, equitable, and supportive for all genders.
- For instance, inclusive training programs, or the design of software tools that include individuals of all genders ensuring they are intuitive for everyone
- Might need extra effort to maintain the gender neutrality of circular manufacturing in public opinion.

22. Do you think the new technologies and solutions in CIRCMAN5.0 will address specific gender-related concerns (e.g., workload, safety, work-life balance) in industrial and manufacturing roles?

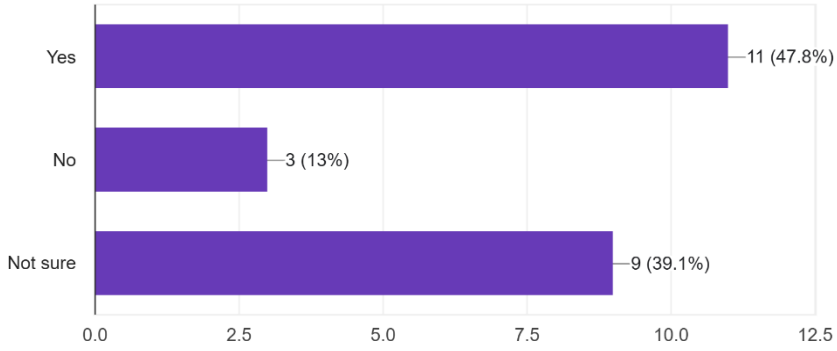


23. Please elaborate

Responses:

- Not specifically, but they might have an impact
- The technologies and solutions in CIRCMAN5.0 have the potential to address important gender-related concerns in manufacturing, such as workload, safety, and work-life balance, by leveraging automation, AI, IoT, and remote capabilities. However, these technologies alone will not solve gender inequities without intentional design, inclusive policies, and careful monitoring. By proactively addressing biases, promoting flexible work arrangements, and encouraging diversity in leadership and innovation, CIRCMAN5.0 can help create a more inclusive, equitable, and supportive environment for employees of all genders in the industrial and manufacturing sectors.
- See question on work to be done by partners previously. This would be nice to have a scientific based perspective on.
- The technologies in CIRCMAN 5.0 bear no relation to gender concerns. At the same time, I would not let my employer go around asking details about employees private lives. I am fine with them not making any difference.

24. In your opinion, are there any intersectional factors (such as age, ability, or cultural background) that might affect how individuals experience the transformation in circular manufacturing sector?

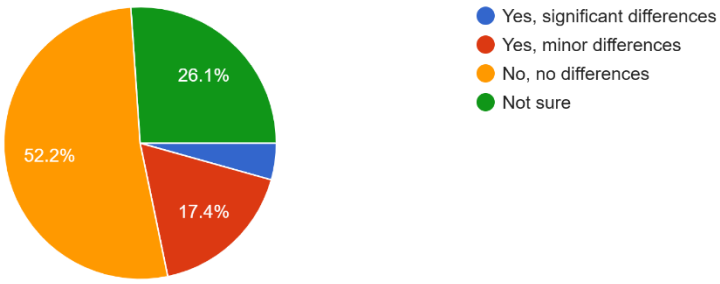


25. Please elaborate

Responses:

- Age and cultural background might be critical and represent a risk for the adoption of new technologies
- Intersectional factors such as age, ability, cultural background, and socioeconomic status significantly impact how individuals experience the transformation in the circular manufacturing sector. Recognizing and addressing these factors is essential to creating a truly inclusive and equitable industry. By adopting strategies that consider the diverse needs of its workforce, circular manufacturing can become a leading example of an inclusive, forward-looking sector where all individuals can contribute to and benefit from the transition to a sustainable economy.
- Age: Younger employees may adapt more easily to new technologies than their older counterparts. Language barriers can affect access to training and communication about new technologies. Education level: individuals with higher educational backgrounds may find the transition to a circular economy easier.

26. Have you noticed any gender differences in perceptions toward circular manufacturing technologies or roles within this field?



27. Please elaborate

Responses:

- The difference is more related to the perception of digital technology and STEM in general (always considered male domain)
- People's gender identities are outside the work environment scope. I don't go around asking people about their gender identity, so therefore I wouldn't know how each gender perceives circular manufacturing.

The Gender Analysis Survey, conducted as part of the DMP, was completed by 24 project partners, focusing on gender-related awareness, policies, and recommendations.

- 80% of respondents indicated that EU projects address gender-related statistics and policies, while only 20% were aware of the EU Gender Equality Strategy 2020–2025.
- Some partners have Gender Equality Plans (GEPs) to provide guidance on gender inclusivity, while 90% of those without such policies agreed that having formal documentation would be beneficial for improving organizational gender policies.

To promote gender awareness and inclusivity, CIRCMAN5.0 will organize workshops on gender-related topics and encourage greater participation of women in research presentations.

7.2 Legal Framework

Besides the general data handling guidelines and ethical considerations, this DMP also specifies that the project partners should ensure the issues related to data protection and privacy (arising from the preparation, conduction and analysis of user and stakeholder interactions and different pilot activities) are addressed in line with European and national legislation and directives relevant to the country where the data is being processed.

In this way, a specific guideline for the CIRCMAN5.0 partners is to adhere to the following regulations and policy documents when performing data processing (personal and non-personal):

- Automatic processing of personal data should be done in accordance with The Universal Declaration of Human Rights[15] and the Convention 108[16].
- All partners must follow the charter of fundamental rights of the EU[17].
- EU Directive 2002/58/EC on Privacy and Electronic Communications (and its amendment, Directive 2009/136/EC) for electronic communications involving personal data. This directive will be applied to maintain the security of electronic communication services such as 1) Restricting access to personal data to authorized personnel; 2) preventing any damage to personal data from being lost or altered either intentional or accidental; 3) enforcing the security policies for the personal data processing[18].
- EU Regulation (EC) No 45/2001 for the protection of personal data processing by community institutions and bodies[19].
- EU Sustainable Finance Taxonomy Regulation (Article 9 and 17) for not harming the environmental objectives[20].
- Processing of personal data and the free movement of such data should be performed in accordance with Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016, which is also in line with Directive 95/46/EC (General Data Protection Regulation)[21].
- Harmonised rules for fair access and data usage should be done in accordance with Regulation (EU) 2023/2854 of the European Parliament and of the Council of 13 December 2023 which introduces some specific provisions to existing the Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act)[22].
- Cybersecurity measures (such as encryption, secure coding and authentication/authorization) must be integrated in the research and deployment

[15] https://www.un.org/en/universal-declara>on-human-rights/
[16] https://www.coe.int/en/web/conven>ons/full-list/-/conven>ons/treaty/108
[17] Charter of Fundamental Rights of the European Union (OJ C 202, 7.6. 2016, pp. 389–405)
[18] https://eur-lex.europa.eu/eli/dir/2002/58/oj/eng
[19] https://eur-lex.europa.eu/eli/reg/2001/45/oj/eng
[20] https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en
[21] https://eur-lex.europa.eu/eli/reg/2016/679/oj
[22] https://eur-lex.europa.eu/eli/reg/2023/2854

activities of the project in accordance with the Cybersecurity Act[23] to incorporate security by design approach.

- The digital elements of the products developed in the project must follow the Cyber Resilience Act[24] throughout the whole lifecycle from the design to deployment.

7.2.1 EU AI Act

CIRCMAN5.0 project will consider the regulations of the EU AI Act which entered into force on August 1, 2024, and its provisions will be applied in phases. The immediate action to be considered by all partners that are involved in the development of AI solutions is to perform the self-assessment of whether the AI systems fall under "unacceptable risks" or not. The AI Act is the first comprehensive legal framework to address risks associated with AI. The following are some of the general ethical and legal obligations that are specified for the AI developers, users and providers:

- The AI system should have robust security measures to avoid data breaches and unauthorized design access.
- AI operations should be transparent and allow users to understand and challenge decisions made by an AI system.
- Fairness should be ensured, and biases should be avoided when designing an AI system preventing any unfair actions towards vulnerable populations.
- There should be identifiable parties responsible for the AI system which can provide redress in case of any unintentional harm.
- AI systems should have a positive impact on societal and environmental well-being.

AI systems to be utilized or developed within CIRCMAN5.0 such as:

- Cognitive Digital Twin (CDT),
- ML-assisted Production Planning,
- Circularity and Life Cycle Assessment (LCA) Framework,
- Trustworthy AI-driven Environmental-Aware KPI Forecasting,
- Human-in-the-Loop (HITL) Recommendation Engine, and
- AI-driven Parametric Techniques for Product Eco-Design,

will undergo assessment later in the project when these tools are fully developed. The evaluation will determine their relevance to compliance with the EU AI Act.

7.2.2 Ethics for Trustworthy AI

Artificial Intelligence-High Level Expert Group (AI-HLEG) has published ethics guidelines for trustworthy AI in 2019. Based on these guidelines, trustworthy AI should have the following three components:

1) Lawful: It should be compliant with applicable laws and regulations
2) Ethical: It should adhere to ethical principles and values

[23] Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act).
[24] Cyber Resilience Act, available at: https://digital-strategy.ec.europa.eu/en/library/cyber-resilience-act

3) Robust: It should be robust from a technical and social perspective and should not cause any intentional or unintentional harm.

The concept of Trustworthy AI is introduced by AI-HLEG to European commission based on the following seven key requirements:

1. Human agency and oversight
2. Technical robustness and safety
3. Privacy and data governance
4. Transparency
5. Diversity, non-discrimination and fairness
6. Environmental and societal well-being and
7. Accountability

The guidelines from the above seven key requirements are captured in a questionnaire which consists of 13 questions, listed in Appendix A. Based on the analysis, the following 11 tasks and subtasks have been identified where AI based solutions will be used/developed in the CIRCMAN5.0 project:

1. Subtask T3.2.1 Data mining.
2. T3.3 AI-driven parametric techniques for product eco design
3. T3.4 ML-assisted Production Planning.
4. Subtask T3.4.1: Embedded edge computing system for the automatic detection of multi-type defects.
5. T3.5 Cognitive Digital Twin (CDT).
6. T3.6 CDT-driven Decision Support System.
7. T4.2 AI-based algorithms for distribution routing.
8. T4.3 Trustworthy AI-driven Environmental-aware KPIs Forecasting.
9. T4.4 Circularity and Life Cycle Assessment (LCA) framework.
10. T4.5 Human-in-the-Loop (HITL) Recommendation Engine.
11. T5.2 Data integrity through cybersecurity protocols.

The responses received on AI self-assessment from technical partners are summarized below:

Out of 11, only one task (T3.3 AI-driven parametric techniques for product eco-design) identifies a baseline risk in data processing that affects mainly the individual privacy and human autonomy. To minimize the identified risk, CIRCMAN5.0 will adopt the following procedures:

- Use storage system and transmission protocols which are in line with principles of privacy by design (see examples below).
- Access to sensitive data will be handled by the Data controller and processor defined in this deliverable.
- Appropriate data minimization techniques will be applied.
- Obtaining informed consent for personal data processing.
- Applying anonymization techniques.
- Standard security protocols such as HTTPS will be followed.
- Encryption techniques such as AES will be applied to secure the data.

- All the project partners must also ensure implementation of mechanisms for accountability for different processing techniques applied on personal and non-personal data and their outcomes, especially in the case of AI models.
- There should be an accountable person responsible for the decisions made by the AI systems and implementing necessary measures if any harm is identified.
- The AI solutions in the CIRCMAN5.0 project should be designed to avoid biases and maintain fairness and transparency.

To ensure the AI system's integrity, robustness and overall security against potential attacks over its lifecycle, all tasks will perform certain measures such as:

- The system will be simulated and will be tested based on certain attack scenarios. The AI system will be aligned with specific security and privacy levels and standards as they are mentioned in the respective scientific literature.
- Implementation of secure APIs, to ensure the integrity, robustness, and security of the AI system against potential attacks throughout its lifecycle. Additional safeguards, such as regular security updates, further enhance the system's resilience
- The AI system's security is ensured by the overall cyber-security measures in the CIRCMAN5.0 platform, including measures to protect the platform for unauthorized access, and AI-aided threat and intrusion detection.
- Systems can be filtered to obtain controlled behavior in order to minimize the potential attacks and to increase robustness of AI System.

CIRCMAN5.0 will ensure that AI solutions used/developed will maintain a high level of accuracy that will minimize any critical, adversarial or damaging consequences.

While some of these AI solutions may have a low level of accuracy such as:

- T5.2: Data integrity through cybersecurity protocols,
- T3.5 Cognitive Digital Twin (CDT),
- T3.4.1 Embedded edge computing system for the automatic detection of multi-type defects,

these might have consequences depending on their use such as errors in analysis or decision-making processes, potentially impacting operational efficiency, resource allocation or strategic planning.

In CIRCMAN5.0, the AI systems' output is in the form of recommendations and includes human-in-the-loop functionalities, so it does not lead to completely automated decisions. Also, these AI systems do not deal with safety-sensitive domains, such as healthcare or financial system so such critical consequences are not anticipated.

To ensure that the data used for AI system is up-to-date and consider environmental factors. The following measures will be put in place by technical partners:

- Using the latest datasets and applying regular data quality checks. The AI models will be updated (re-training and testing) whenever the environment changes.
- Technical robustness is prioritized, and an n-fold-validation process is foreseen to rectify potential biases. In addition, the transparency and explainability functionalities ensure understanding of the AI system's outputs and functionalities.

Within CIRCMAN5.0, erroneous predictions (e.g. about an asset's predicted lifetime or environmental impact) cannot critically affect human safety. Overall, the AI system is intended to increase asset reliability and decrease downtime of industrial machinery. Training and validation of the AI algorithms will ensure the reliability of the predictive tools, and only the best performing algorithms will be implemented in the production system to avoid any damage to human safety.

The AI systems of the CIRCMAN5.0 project such as Cognitive Digital Twin (CDT), ML-assisted Production Planning and Circularity and Life Cycle Assessment (LCA) framework are not envisioned to use any kind of personal data.

The project will apply guidelines for traceability of the AI system during the design process. These will include a detailed description of the methods used for designing algorithms, the data used for training and validation, the outcomes of the algorithms and changes in the algorithm design as a result of these outputs.

The following measures will be taken to allow flagging issues related to bias, discrimination or poor performance of the AI system:

- The system operator will be notified in time when the predefined acceptance threshold is violated
- The AI models will be designed to be interpretable, allowing stakeholders to understand how decisions are made and to identify potential biases or performance issues.
- Through the combination of proper data pre-processing and statistical analysis to indicate if data is not distributed in a plausible manner.

The AI solutions of CIRCMAN5.0 project are intended to reduce environmental impact by decreasing the impact of industrial PV assets compared to the current situation and providing support for optimal management decisions.

The CIRCMAN5.0 project will utilize an Information Modeling Framework comprising an auditability mechanism for ensuring trust in the data. Apart from data auditability, there will be complete logging of the AI design and performance, that could serve auditing purposes.

Third parties will be able to audit the CIRCMAN5.0 AI systems (after certain approvals), focusing on aspects like transparency in training, data practices, security, and continuous monitoring. These audits aim to ensure accountability, and compliance with regulations, and that the system operates ethically and responsibly throughout its lifecycle.

Based on the responses received from the AI solution providers and its careful analysis, we have made a conclusion that there will be no implications related to human autonomy and data protection. CIRCMAN5.0 project will be focused on ensuring that proper guidelines and measures are in place so that AI development is in line with AI-HLEG guidelines. Processing of personal data is not envisioned for training of AI models at this stage and if there is any in the future, will be following GDPR guidelines (GDPR (Regulation (EU) 2016/679))[25].

[25] https://www.legislation.gov.uk/eur/2016/679/contents

8 Conclusion and Future Work

The first version of DMP reports a data management strategy based on Horizon Europe open data requirements. The methodology that will be followed for collection, processing and generation of data in compliance with FAIR data principles is defined. The initial overview of pilots' datasets has been provided in the first iteration.

It also reports guidelines for document sharing among consortium partners. An ethical and legal framework that will be followed in CIRCMAN5.0 is clearly defined. The guidelines are also provided for personal data processing (in accordance with GDPR) and trustworthy AI (in accordance with AI-HLEG).

This report is a live document that will be updated regularly over time as the project progresses and if any new information on the datasets is available. The final version of DMP (D1.5-Data Management Plan and Regulatory, Societal, Gender & Ethical Issues - V02) will be released at the end of project M36 to reflect the developments in the project.

9 List of Acronyms

Acronym	Definition
AI	Artificial Intelligence
AIHLEG	Artificial Intelligence - High Level Expert Group
API	Application Programming Interface
BAPV	Building Adapted Photovoltaics
BIPV	Building Integrated Photovoltaics
CDT	Cognitive Digital Twin
EU	European Union
EoL	End of Life
FAIR	Findable Available Interoperable Reusable
GA	Grant Agreement
GB	Giga Byte
GDPR	General Data Protection Regulation
GEP	Gender Equality Plan
HITL	Human in the loop
HLEG	High Level Expert Group
ID	Identification
IPR	Intellectual Property Rights
ISO	International Organization for Standardization
IEC	International Electrotechnical Commission
IT	Information Technologies
IoT	Internet of Things
JSON	JavaScript Object Notation
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
MS	Microsoft
OEM	Original Equipment Manufacturer
ORCID	Open Researcher and Contributor ID
PV	Photovoltaics
RDF	Resource Description Framework
STEM	Science Technology Engineering and Maths
URI	Uniform Resource Identifier
WP	Work Package
DMP	Data Management Plan

10 Appendix A

Could the AI system affect the human autonomy and privacy of individuals?
Are there measures to ensure the AI system's integrity, robustness and overall security against potential attacks over its lifecycle?
Could the AI system have negative, critical or damaging effects (e.g. to human or societal safety) in case of risks or threats such as design or technical faults, defects, outages, attacks, misuse, inappropriate or malicious use?
Could a low level of accuracy of the AI system result in critical, adversarial or damaging consequences?
Are there measures to ensure that the data (including training data) used to develop the AI system is up-to-date, of high quality, complete and representative of the environment in which the system will be deployed?
Could the AI system cause critical, adversarial, or damaging consequences (e.g. pertaining to human safety) in case of low reliability and/or reproducibility?
Will the AI system be trained or developed by using or processing personal data (including special categories of personal data)?
Will there be in place measures that address the traceability of the AI system during its entire lifecycle?
Is there a mechanism that allows for flagging issues related to bias, discrimination or poor performance of the AI system?
Are there potential negative impacts of the AI system on the environment?
Are there mechanisms that facilitate the AI system's auditability (e.g. traceability of the development process, the sourcing of training data and the logging of the AI system's processes, outcomes, positive and negative impact)?
Can independent third parties audit the AI system?