FAIRICUBE –
F.A.I.R. INFORMATION CUBES

WP6 - Disseminate
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1 Introduction

In the rapidly evolving field of artificial intelligence (AI) and data science, ethical considerations have become increasingly critical. The integration of AI into various sectors, from healthcare to finance, education, and beyond, necessitates a comprehensive framework to ensure that these technologies are developed and deployed responsibly. The Z-Inspection® co-design process offers a structured methodology for evaluating the ethical implications of AI projects, emphasizing a collaborative and interdisciplinary approach. This deliverable delves into the application of the Z-Inspection® process for assessing the ethical dimensions of a data science project, providing an overview of its principles, methodology, and significance.

AI technologies hold immense potential to transform society by enhancing productivity, enabling new capabilities, and improving quality of life. However, these benefits come with risks and ethical dilemmas that must be addressed to avoid unintended consequences. Issues such as bias, privacy violations, lack of transparency, and accountability gaps can undermine public trust and lead to significant harm. Ethical AI practices ensure that these technologies align with societal values and respect human rights, fostering an environment where innovation can thrive responsibly.

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2 Z-Inspection® co-design process

The Z-Inspection®[1] is an ethical assessment framework specifically designed to evaluate AI systems. It was developed to provide a rigorous, transparent, and multidisciplinary approach to AI ethics. The process is rooted in the principles of Responsible Research and Innovation (RRI) and is characterized by its emphasis on inclusivity, transparency, and accountability. Z-Inspection® aims to identify potential ethical issues throughout the AI lifecycle, from conception to deployment, and offers guidelines for mitigating these risks.

2.1 Core Principles of Z-Inspection®

Core Principles of Z-Inspection® comprise of following items:

- Inclusivity: Engaging a diverse group of stakeholders, including ethicists, engineers, domain experts, and the public, to ensure that multiple perspectives are considered.
- Transparency: Maintaining clear and open communication about the AI system's capabilities, limitations, and decision-making processes.
- Accountability: Establishing clear responsibilities and mechanisms for addressing ethical concerns and ensuring that AI systems adhere to ethical standards.

2.2 Methodology

The Z-Inspection® process is divided into several stages, each designed to comprehensively evaluate the ethical aspects of an AI project:

- Context Understanding: Analysing the specific context in which the AI system will operate to identify relevant ethical considerations.
- Ethical Impact Assessment: Evaluating the potential positive and negative impacts of the AI system on various stakeholders.
- Ethical Risk Mitigation: Developing strategies to mitigate identified risks and ensure compliance with ethical standards.
- Continuous Monitoring and Evaluation: Implementing ongoing monitoring mechanisms to ensure that the AI system continues to operate ethically throughout its lifecycle.

This process aims to help you understand the AI system in its wider context. By answering a number of predefined questions, the FAIRiCUBE use cases can identify possible ethical opportunities and challenges.

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2.3 Co-Design in Z-Inspection®

Co-design is a fundamental aspect of the Z-Inspection® process, emphasizing collaborative and iterative development involving all relevant stakeholders. This approach ensures that the AI system is designed with a comprehensive understanding of the ethical implications and that ethical considerations are integrated into every stage of the project. By fostering a participatory environment, co-design helps to build trust and accountability, leading to more robust and ethically sound AI systems.

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3 Socio-technical scenario questions

A trustworthy AI assessment is only complete if it considers the technical components within a broader context. What can be considered ethical or problematic strongly depends on the broader societal context where the AI system is used, with consideration of people, institutions, and cultures. The methodology, therefore, involves using so-called socio-technical scenarios. These scenarios help anticipate possible usage and problems of the system under review. The scenarios are built around experiences resulting from the AI system's intended use. We create a socio-technical scenario template using a predefined set of questions:

1. Aim of the system
2. Actors
3. Actors' Expectations and Motivation
4. Actors' Concerns and Worries
5. Context where the AI system is used
6. Interaction with the AI system
7. AI Technology used
8. Clinical studies /Field tests/ Other Evidence
9. Intellectual Property
10. Legal framework
11. Ethics oversight and/or approval.

Some of these questions have sub-questions that shall guide the responding party to understand the questions and provide appropriate replies. The question scheme has been made available as a MS Forms online form, a screenshot is shown in Figure 1 and the full pdf export is available in the Annex 1 – FAIRiCUBE Z-Inspection® Co-design forms. Collecting and evaluating feedback from all several parties and actors in FAIRiCUBE is thereby streamlined and can be re-used in the future.

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FAIRiCUBE Z-Inspection® Co-design

Creating and Analyzing a Socio-Technical Scenario

Use this template to define your FAIRiCUBE use cases.
An example of the answered template can be found here:
https://docs.google.com/document/d/1uwiYLCu1AqSroVzZZe31tmi3yHOnLpX1p2cixfAiKQI/edit

Please fill out the forms even if you have created a separate document for internal collaboration.

1. FAIRiCUBE Use Case *

- ◯ UC 1: Urban adaptation to climate change
- ◯ UC 2: Agriculture and Biodiversity Nexus
- ◯ UC 3: Environmental Adaptation Genomics in Drosophila
- ◯ UC 4: Spatial and temporal assessment of neighbourhood building stock
- ◯ UC 5: Validation of Phytosociological Methods through Occurrence Cubes

2. Aim of the system *

The goal of the system, context, and why it is used.

- What is the scientific problem you are trying to solve?
- What is the technical part of this problem you try to solve?
- What is the solution/goal of the system?

Enter your answer

3. Actors
*

Use the following guiding questions to identify different actors.

- Who designed and will implement the system?
- Who has authorized the deployment of the system or prototype?
- Who is currently using the system?
- Who are the end users of this system?
- Who is directly influenced by decisions made by the system?
- Who is indirectly influenced by decisions made by the system?
- Who is responsible for this system?

Enter your answer

Figure 1 : Screenshot of FAIRiCUBE Z-Inspection® Co-design forms

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3.1 Use case response

As AI related work is conducted and executed as part of the FAIRiCUBE use case work, all 5 FAIRiCUBE UCs:

- UC 1: Urban adaptation to climate change
- UC 2: Agriculture and Biodiversity Nexus
- UC 3: Environmental Adaptation Genomics in Drosophila
- UC 4: Spatial and temporal assessment of neighbourhood building stock
- UC 5: Validation of Phytosociological Methods through Occurrence Cubes

have been asked to go through the socio-technical scenario questions and provide their UC view and answers. A first guided walkthrough was conducted with the Ethics board and UC3 to test the questions and provide a reference case for the other UCs. All UCs have been encouraged to try to answer as many questions as possible. If a question does not apply, feedback is requested why. The forms can be resubmitted any time and an aggregated/merged reply can be created. The complete record of answers from each UC is available in Annex 2 – Use case replies to the FAIRiCUBE Z-Inspection® Co-design forms.

3.2 Summary of the UC response

Based on the detailed replies of the FAIRiCUBE use cases (UCs) to the 11 socio-technical scenario questions, we have been summarizing and abstracting a general response in the following subchapters. This is the foundation for the AI ethics assessment checklist.

3.2.1 Aim of the AI system

The AI systems in FAIRiCUBE aim to facilitate the integration, analysis, and simulation of diverse datasets to support various environmental and urban planning applications. By harmonizing heterogeneous data into structured formats like data cubes, the system provides a platform for advanced data processing and machine learning applications. Its objectives include assisting cities and institutions in planning and assessing climate adaptation strategies, enhancing habitat classification through the integration of satellite data and species occurrences, standardizing data and methods for analysing environmental influences on genomic variation, investigating the impacts of agricultural activities on biodiversity and improving data access, and estimating buildings' energy performance and environmental footprint using computational models. Overall, the AI systems support environmental sustainability, urban resilience, and scientific research through advanced data integration and machine learning techniques.

3.2.2 Actors of the AI system

Based on the provided UC answers a summarized and aggregated list of the actors involved in the AI systems is provide in Table 1.

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Table 1 : Actors of the FAIRiCUBE AI systems

Design and Implementation	Use case owners and contributors
Authorization for Deployment	FAIRiCUBE Consortium, other consortia related to the specific domain
Current Users	Use case owners and contributors
End Users	• Stakeholders, city administrators, policy makers • Academics, researchers, data scientists • Domain specialists (vegetation ecologists, phytosociologists, botanists, evolutionary biologists) • Industry, medical sector, NGOs focusing on environmental protection • Farmers, conservationists
Direct Influence	• Stakeholders, policy makers • Users of the system (academics, researchers, city planners)
Indirect Influence	• Citizens • Species affected by food industry • Policy makers informed by environmental change data
Responsibility	Use case owners and contributors

3.2.3 Actors' Expectations and Motivation

In the course of the FAIRiCUBE UC work, system developers and data scientists aim to simplify and expedite the analysis process, expecting the system to respond quickly, offer transparent insights, and quantify result uncertainty. End users, such as urban planners and decision-makers, want the system to analyse urban areas and simulate climate adaptation measures, sharing similar expectations for fast and understandable responses. Experts in vegetation communities are motivated to improve knowledge and classification methods, anticipating a robust data gathering and processing pipeline. Genomics data scientists focus on addressing gaps in data to enhance predictive power, with the expectation that more complete data will improve the performance of machine learning algorithms. Overall, all users desire a system that facilitates decision-making, provides easy access to data and workflows, and delivers accurate, explainable, and actionable insights.

3.2.4 Actors' Concerns and Worries

The actors of the FAIRiCUBE AI systems are concerned about several key issues regarding their ML/AI models and data. First, they highlight problems with data quality, including insufficient reference or validation data, skewed distributions, and availability issues. These data challenges make it difficult to validate model performance and ensure accuracy. Additionally, the use of categorical data, particularly Boolean features, presents complications for machine learning.

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There are significant worries about the accuracy and reliability of the models, especially when results are not easily explainable and lack contextual information. Simplistic interpretations by non-AI experts or scientists with limited ML skills could lead to misunderstandings, while NGOs or political groups might misuse the system for their own agendas. Technical shortcomings, such as reliance on generic models that cannot produce accurate estimations, further complicate the situation. The need for additional numerical data, like DEM derived and climate data, is emphasized to improve model training.

3.2.5 Context where the AI system is used

The AI applications executed in FAIRiCUBE span various domains, primarily focusing on environmental and socioeconomic data analysis. One application involves assessing climate change adaptation measures using machine learning (ML) to evaluate effectiveness against expected outcomes. This AI system supports academic, public, and environmental purposes. In another scenario, ML is applied to genetic data of fruit fly populations for gap filling in DNA sequencing, crucial for establishing relationships with environmental factors. A third scenario demonstrates the initial use of causal ML in agriculture and biodiversity studies, expanding into broader environmental sciences.

Additionally, ML techniques are being tested for estimating building age and rooftop geometry. This aids in evaluating building energy efficiency and determining construction materials, highlighting applications in urban planning and sustainable architecture. Overall, these AI applications illustrate diverse uses across environmental science, genetics, agriculture, and urban planning, leveraging ML for data-driven insights and decision-making.

3.2.6 Interaction with the AI system

The FAIRiCUBE AI system facilitates user interaction primarily through predefined analysis and AI models applied to both existing and new data cubes. Users have autonomy in selecting data inputs and interpreting results, aided by explainable AI components for transparency. One application involves training machine learning models to predict species distribution based on abiotic factors, comparing results with habitat classifications. These models will be accessible for users to implement the EUNIS classification and study species distribution using data from sources like GBIF and EO, without direct oversight from the creators.

Another application focuses on gap filling, where an ML model is trained on a subset of data and deployed to fill gaps in other datasets. Users can independently apply this model, although responsibility for its appropriate use lies with them. A feedback loop is emphasized to signal issues for retraining the model. Users play a significant role in setting model parameters and creating scenarios, enhancing the system's flexibility. Currently in development, the system aims to evolve into a Python toolbox capable of generating results based on user requests in the future.

3.2.7 AI Technology used

Withing the FAIRiCUBE UC work, the AI system employs a range of machine learning techniques tailored to specific tasks. It begins with unsupervised learning methods, particularly clustering analysis like K-means, to organize and explore datasets. For classification and prediction, the system utilizes statistical

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and machine learning models such as random forest (e.g., xgboost) and conducts time series trend analysis. Additionally, pretrained neural networks are considered for classification and prediction tasks, although exact models are yet to be specified.

Initially, one ML approach centres on implementing a random forest model. This model uses species data and various numerical features, emphasizing feature importance analysis and adjusting data weighting and balancing techniques as needed. The system also addresses data completeness by introducing artificial gaps into complete datasets to simulate real-world scenarios. Ongoing validation ensures these gaps accurately reflect genuine data gaps.

Recent advancements include integrating deep learning methods and regression techniques into the workflow. While technical details are being refined, the system is leveraging deep learning approaches alongside regression for enhanced analysis. Looking forward, the system plans to explore advanced machine learning techniques such as Variational Autoencoders (VAE) and Generative Adversarial Networks (GAN) to tackle more complex data challenges effectively.

In essence, the AI systems are strategically employing a combination of supervised and unsupervised learning methods, backed by sophisticated models and techniques, to handle diverse datasets, address data completeness issues, and advance predictive capabilities in its applications.

3.2.8 Clinical studies /Field tests/ Other Evidence

The AI systems under discussion have not undergone formal validation but rely solely on publicly available data and existing software. Clinical studies and field tests are not included in the UC work being referenced. Instead, the focus is on employing causal and explainable AI to retrospectively validate expected causal relationships using environmental data, albeit with a certain degree of robustness. These validation studies are currently incomplete. Future plans involve making data accessible at a broader spatial resolution to anonymize individual species observations and prevent direct links to specific farms.

3.2.9 Intellectual Property

All work in the FAIRiCUBE project and especially the AI systems operate under principles of open access and proper citation of source data and software, following specific licenses. It does not handle confidential information and does not foresee any such data being used. Data utilized may have restrictions, such as sensitive agricultural data being published only in coarse resolution, and only spatially aggregated or generalized data will be employed, avoiding inference to individual farm data. The source code developed within the project adheres to the MIT license, allowing unrestricted inspection. Mainly utilizing Python ML tools, open-source data, and academic publications ensures compatibility and eliminates potential issues with usage. These aspects underline a commitment to transparency, attribution, and adherence to licensing terms while leveraging openly available resources for the project.

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3.2.10 Legal framework

The FAIRiCUBE AI system operates under a framework where all data and software used are subject to licenses permitting reuse, modification, and distribution, with different licenses applying to different components. There are no specific regulations governing the system, and it currently processes only publicly available data, avoiding sensitive information. Compliance with GDPR is maintained for applicable data processing. The systems have not been classified as high risk.

Data usage adheres to open-source principles, and most data used is already open and publicly available, supporting publishing and scientific integrity. Users are expected to use the system ethically and responsibly, aligned with university regulations and ethical guidelines inherent in research practices. Specific legal considerations include adherence to the AI Act and GDPR requirements. Durch farmland data (NDFF) and species observation data is licensed with restrictions to prevent individual recognition, mandating data aggregation to at least 100m resolution. Overall, the AI systems operate within a legal framework emphasizing open access, ethical use, and compliance with relevant data protection and licensing regulations.

3.2.11 Ethics oversight and/or approval

The FAIRiCUBE UC responses indicate diverse approaches to ethics oversight and approval in AI development. One response suggests that no ethical assessment was deemed necessary because the AI system exclusively utilizes openly available data, posing no ethical challenges or potential for harm. Another response acknowledges that the AI system is in its developmental stage without prior ethical assessment. Additionally, there was mention of a preliminary Z-Inspection® round that determined the AI system to be low-risk, though this assessment was specific to a particular phase within the project. Lastly, in a different context, it was clarified that no AI system is currently under development or in use, hence no ethics oversight is required in that instance. These varied responses illustrate the nuanced considerations and actions related to ethics oversight and approval in different stages and contexts of AI system development.

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4 Implementation and next steps

The summary of the UC response to the socio-technical scenario questions is input for a draft AI ethics checklist as shown in Table 2. This checklist shall be seen as one of many validation activities that all are formulated as user-friendly and easily accessible checklist. The FAIRiCUBE deliverable *D1.2 Validation report* describes all the validation activities and puts them in context and hierarchy. A future outlook on an online implementation of the checklists is given there as well.

Table 2 : AI ethics assessment checklist

	Description	**Answer, status of implementation, timeline for implementation**
Ethics (Trustworthy AI)		
Fundamental rights	How are you dealing with the effect of the application on the rights to safety, health, non-discrimination, and freedom of association?	
Privacy and data protection	How are you implementing the GDPR to safeguard the personal data protection rights of those you collect personal data from?	
Transparency rights	Do you include the following user rights to: be notified that their data is being processed/collected, access information on which personal data are collected, control their data, access explanations of results produced by the system, be informed of who, when and how the system can be audited.	
Accessibility	Can your app/system/resource be used by all regardless of demographics, language, disability, digital literacy, and financial accessibility?	
Education and tutorials	Do you ensure that users are informed and capable of using the system correctly?	
Data management	Do you comply with the data-minimization principle, i.e. usage of local and temporary storage and encryption, based on principles of data protection by design? Do you ensure that only strictly necessary data are captured and processed?	
Security	Do you have user authentication in place to prevent risks such as access, modification, or disclosure of the data? Do you use unique and pseudo-random	

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	identifiers, renewed regularly and cryptographically strong?	
Ease to deactivate/remove	How easy is it to deactivate or remove the system and data once users are no longer interested or need the system?	
Ease to access services without using the AI system	In the case of AI systems aimed to replace or complement (public) services, are there full non-system alternatives?	
Open-source code	Is the development participatory and multidisciplinary? What kind of access to the code and development is there?	
Ownership	Is the ownership of the resource clear?	
Openness about Data governance	How open is Data governance? Do you have a policy and actions to share data under an open data license?	
Legislation and Policy	Are there explicit legislation and/or other policies relevant to your system/resource?	
Design Impact Assessment and Open Development Process	How publicly accessible is the information about the design process leading to this resource?	
Right to contest/liability	How are users able to contest decisions/actions or demand human intervention?	
GDPR applicability		
List of data	List the types of data you will process in your pilot	
Personal data?	Will personal data be processed for the proposed pilot? Personal data is understood as data that may directly or indirectly identify a natural person.	

As for now, this checklist has only been conceptionally verified with the use cases under FAIRiCUBE and is mostly meant to provide guidance and concrete AI Ethics assessment validation steps to follow. Further, the guidance shall be applicable to all current and future use cases executed under FAIRiCUBE and in principle every data science framework. No use case specifics are therefore included and the checklist as the simplified and potentially main output of this deliverable will not contain results of the validation of the processing and ML applications. It is foreseen to make a webservice form from Table 2 with an optional field for comments for each checkbox item and the guidance results with comments can be harvested and provisioned as part of the Knowledge Base services.

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5 Summary

The Z-Inspection® co-design process represents a comprehensive approach to addressing the ethical challenges associated with AI and data science projects. By emphasizing inclusivity, transparency, and accountability, it provides a robust framework for ensuring that AI technologies are developed and deployed responsibly. As AI continues to permeate various aspects of society, the importance of ethical considerations cannot be overstated. The Z-Inspection® process offers a path forward, enabling the creation of ethical, trustworthy, and socially beneficial AI systems.

The FAIRiCUBE use cases have been providing detailed answers on 11 the socio-technical scenario questions which was summarized and abstracted to help setup a general AI ethics assessment checklist which can be used for the review and assessment of the current as well as future data science use cases that are executed under the FAIRiCUBE Hub. The checklist will be integrated in the FAIRiCUBE validation framework and - as a next step - will be made available as a user-friendly web service for the collection, documentation and sharing of validation information.

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Annex 1 – FAIRiCUBE Z-Inspection® Co-design forms

In the following a full pdf export of the Microsoft teams form distributed to all the FAIRiCUBE use case is attached.

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Annex 2 – Use case replies to the FAIRiCUBE Z-Inspection® Co-design forms

In the following a full pdf export of the FAIRiCUBE use case replies to the Microsoft teams is attached.

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