D1.9 Report on Legal, Privacy, Ethical and Social Aspects (c)

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Executive summary

D1.9 Report on Legal, Privacy, Ethical and Social Aspects (c) due at M36 (August 2025 is the third and last deliverable dealing with the ethical issues expected to be addressed during the MUSAE project execution.

This third edition provides an analysis from an ethical perspective of the Data Management Plans (DMPs) provided by the 11 participating teams along the prototyping phase of the second art-tech experiment characterised by a strict collaboration between technical and artistic partners actualising each scenario. Across all projects, attention was given to GDPR compliance, anonymization, and ethical considerations, though the level of sensitivity and future risks vary.

Overall, the projects demonstrate strong commitment to GDPR compliance and responsible data practices. However, long-term ethical considerations remain central - particularly regarding sensitive physiological data, experiential feedback mechanisms, image use, and emerging biomaterials. Addressing these issues systematically after the MUSAE project will be essential to ensure that innovation proceeds in a way that is transparent, safe, and socially responsible.

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1. Introduction

1.1. Purpose of the document

Purpose of the different editions of this document is to present and discuss the ethical implications of the research work carried out in the MUSAE project.

Ethical matters are managed within T1.4 Privacy and ethics management of the project, running from M4 (December 2022) to the end of the project (M36 - August 2025).

The different steps of the project, in particular the management of the two open calls, the running of the individual projects leading to MUSAE scenarios definition and the final prototyping of the identified solutions, are accurately planned and monitored to avoid any potential ethical or legal issue by means of an ethics by design approach.

The data collection and processing in MUSAE are designed and conducted in full respect to the fundamental ethical principles, including those reflected in the European Convention of Human Rights and the Charter of Fundamental Rights of the European Union, taking into account the opinions of European Group on Ethics in Science and New Technologies (EGE).

An Ethical Project Committee (EPC) has been setup in M4 (December 2022) to manage all ethical issues in the different phases of the MUSAE project. It has the responsibility of monitoring the conformity of the project to the ethical standards and address all the ethical issues of the project.

Next **Chapter 2** briefly presents the main ethical, legal, social and privacy-related issues, if any, related to Data Collection and Management for the 11 prototypes developed within the second art-tech experiment run from September 2024 to June 2025. During the prototyping, the teams were required to fill in a shared template (Data Management Plan) to address the key areas of data management.

Main messages to be taken into account are summarised in Chapter 3.

2. Data Management Plans of the 11 MUSAE prototypes

2.1. BeeSustain

BeeSustain is a project that promotes sustainable beekeeping practices while monitoring biodiversity in response to the growing challenges of climate change and the rise of synthetic food production.

2.1.1. Data set

The BeeSustain_Flora_Serbia dataset is intended to provide comprehensive data on honey-producing flora in Serbia to support beekeepers in optimal hive placement, enhance biodiversity awareness, and educational purposes via the BeeSustain mobile app and artbook.

it is a structured dataset containing comprehensive botanical information about plant species relevant for honey production in Serbia. The dataset includes 83 plant species with attributes such as local and Latin names, flowering periods, nectar quality, pollen quality, detailed descriptions, and corresponding images. Data was gathered through verified secondary sources. It is integrated into the BeeSustain Art Book and mobile application, enabling visualization of biodiversity and aiding optimal hive placement.

Non-sensitive data and public images/descriptions will be made openly available.
They are expected to be used for educational purposes, environmental research, biodiversity monitoring, and optimization of beekeeping activities, particularly nectar prediction.

2.1.2. GDPR compliance

The lawfulness, fairness, and transparency of the BeeSustain_Flora_Serbia dataset is assured by adhering to strict data governance principles:

- Lawfulness: Data collection complies with GDPR and ethical guidelines, using only publicly available, field-collected, or voluntarily contributed information with consent.
- Fairness: The dataset is curated from diverse and reliable sources, ensuring unbiased representation of flora relevant to beekeeping.
- Transparency: All data sources, processing methods, and updates are documented, and the dataset will be made openly accessible after project completion, allowing verification and reproducibility.

Accuracy is addressed by verifying data through cross-referencing field observations with scientific literature and expert validation.
Storage limitation was maintained by retaining only necessary data while implementing scheduled reviews for outdated or redundant information.
Integrity and confidentiality were upheld through encrypted storage, restricted access controls, and regular data integrity checks to prevent unauthorized access or corruption.

2.1.3. Relevant ethical issues

The BeeSustain project does not raise relevant ethical issues and its data set is well managed according to GDPR. No personal data are collected.

2.2. Fermenting Traditions

Fermenting Traditions is a supportive project that makes microbial activity visible, helping brewers make more informed decisions while preserving the artistry of fermentation of kombucha.

2.2.1. Data set

The generated data set includes: 1) automated data collected through bio sensor technology and 2) manually collected data through a questionnaire for tasting.

The data set consists of a simple Google sheet and it is private (accessible by a shared link).

2.2.2. GDPR compliance

The data set is GDPR compliance being the data collected by questionnaire fully anonymised.

2.2.3. Relevant ethical issues

The Fermenting Traditions project does not raise relevant ethical issues. Only acquired personal data are the ones related to tasting questionnaires but they were correctly anonymised after collection. Data collected through the questionnaire are not sensitive.

The data set is quite small and still under processing.

2.3. Growing futures

Growing Futures is a circular, spiral model that transforms local waste into new habitats through collaboration between humans, mycelium, and robots.

2.3.1. Data set

The collected data includes: 1) sensors data like temperature (°C) and humidity (%), pH level, and Oxygen Levels (%). These data are captured at specific time intervals, formatted in a CSV and Excel sheet with columns for each sensor type, and rows representing timestamps; 2) images captured for mycelium growth analysis. Each image will be stored with a timestamp to link it to the relevant environmental data. The image data will be linked to the sensors data sheet for further analysis.

2.3.2. GDPR compliance

The origin of the acquired data does not require compliance to GDPR.

2.3.3. Relevant ethical issues

At this stage, the Growing Futures project does not raise significant ethical concerns. However,

the future applications and uses of the produced mycelium will require careful ethical consideration, even if such issues are not inherent to the process itself.

2.4. Neurocooking

Neurocooking project aims at a symbiotic practice that blends human intuition with computational intelligence, using haptic guidance to amplify awareness of physiological states and enhance the natural therapeutic rhythm of kneading.

2.4.1. Data set

The collected data includes: EEG, EMG, ECG, movement (by IMU sensors). Data were collected on subjects performing cooking tasks in a laboratory environment.

2.4.2. GDPR compliance

The team ensured the lawfulness, fairness, and transparency of the collected and managed data by adhering to relevant data protection regulations, obtaining necessary permissions for data collection and processing, implementing appropriate security measures, and providing clear and accessible information about how the data is handled even if no detailed information is provided, for example, on informed consent ethical approval to be obtained before data collection on humans.
The team also assured the accuracy, storage, limitation, integrity, and confidentiality of the data managed through strict adherence to data quality standards, secure storage practices, access controls, regular integrity checks, and encryption measures.

Collected data are stated to be used only for scientific research purposes.
The team plans to make the collected data openly available, but, at the current time, they are private.

2.4.3. Relevant ethical issues

The Neuro-Cooking project may raise important questions about the collection of personal data through sensors. To address these concerns, strict ethical oversight should be maintained for all data collection and storage processes, ensuring complete anonymization and protection of participants' privacy.

2.5. Nourish

Nourish is a neurotechnology-driven approach that optimizes user responses to support sustainable health and well-being.

2.5.1. Data set

The project relies on two types of data: automatically generated neurophysiological recordings and manually collected subjective assessments. The core dataset consists of EEG recordings captured automatically by the Enobio 20 system. This technology enables the team to obtain objective neurophysiological measurements, including frequency band powers and event-related potentials, which are critical for understanding the cognitive and emotional impact of food consumption.

Complementing this, the manually collected data derive from structured survey responses, where participants provided subjective feedback on their age, gender, handedness, emotional and cognitive experiences during the experiments. These responses were gathered through standardized questionnaires administered after each session. Together, these data collection methods form a comprehensive dataset that captures both the quantitative and qualitative dimensions of the study, ensuring a holistic analysis of human-food interaction.

Nourish_EEG is a comprehensive dataset that comprises raw and pre-processed EEG recordings along with associated manual survey responses. The EEG data includes measurements such as frequency band powers and event-related potentials, while the survey data captures subjective evaluations of emotional states.

Supplementary datasets include graphical representations of the EEG signals, stored as images, and detailed documentation outlining experimental protocols, processing methodologies, and preliminary analysis.

All datasets are anonymised.

2.5.2. GDPR compliance

The project ensured lawfulness, fairness, and transparency by rigorously following GDPR and related data protection laws, securing necessary permissions, and implementing robust security protocols. Clear, accessible documentation supports our data handling practices. Also, the servers the data is store are GDPR and HIPPA-compliant.

Security of data is obtained by implementing a multi-layered protection strategy. All data is anonymised and is internally stored in secure, access-controlled encrypted and GDPR-compliant environments, where only authorized personnel can retrieve it using credentials. The team enforced strict anonymization to ensure that personal identifiers were never centrally stored or disclosed. Regular audits, audit logs, and robust encryption measures guarantee that data integrity, confidentiality, and compliance with EU and national data protection regulations are maintained throughout the project.

2.5.3. Relevant ethical issues

The data acquired in the project are highly sensitive. While data collection has so far been well managed, potential ethical concerns may arise in relation to future uses of the data.

2.6. BITZ: Biodiversity in Transition Zones

Biodiversity in Transition Zones is a storytelling and data-gathering project that helps identify and share knowledge about the organisms in your surroundings.

2.6.1. Data set

Images were manually collected by the users using the app. Metadata data were automatically generated using a LLM (Large Language Model) for labelling. The LLM is used also to manage interaction with the end users.

The project complies with GBIF standards, following open access principles. These practices include anonymization, documentation and transparency.

The code for the collection and identification of all the data handled within the project is open source to encourage reuse and replication.

The team aims to make the dataset scientifically robust to be explored by the broader scientific community.

2.6.2. GDPR compliance

The team ensured the lawfulness, fairness, and transparency of the data by operating under clearly defined license agreements (GBIF).

Users have to agree to a licence agreement to have their data shared openly when using the app.

2.6.3. Relevant ethical issues

Once the users collecting images are informed of data sharing and their data are fully anonymised, there are no main ethical issues referring to this project that has educational purposes.

2.7. Remedy Garden

Remedy Garden is a functional, scalable system that integrates biological intelligence with architectural performance.

2.7.1. Data set

The project does not build on any dataset for running nor generates additional data. The only generated data are user study responses i.e. a small-scale dataset consisting of 6 survey responses collected during the user study.

2.7.2. GDPR compliance

Once the participants to the study were duly informed, and their data were fully anonymised, GDPR compliance was fulfilled.

2.7.3. Relevant ethical issues

There are no main ethical issues with the implementation of this project nor its future market use.

2.8. S.O.I.L. : Sensing Outer Identities Landscape

Sensing Outer Identities Landscape is an initiative that reconnects human sensory perception with the living dynamics of soil to support a sustainable farming.

2.8.1. Data set

The collected data are dual in nature, as they include both soil data, collected automatically through an IoT sensor, and biometric data, collected automatically through a wearable device. Biometric data is not stored, but used in a closed system. Both categories of data are essential for achieving the project's objectives and are processed in full compliance with current data protection regulations.

The system collects environmental data on soil health via an IoT sensor, which automatically collects the information. This consists of 7 parameters such as moisture, temperature, pH, salinity, conductivity, potassium, phosphorus and hydrogen, referenced to a precise point located via GPS. We also collect biometric data via two sensors (a GSR sensor and a heart rate sensor) placed inside a wearable device. These data provide information about the physiological state of individuals interacting with the environment. The biometric data are not saved but are used by software, and when their use ends, they are erased. Both types of data are essential to the project's research and development objectives and are processed in accordance with current data protection regulations.
In addition, during the course of the research the team has manually collected data such as interviews (audio, document, and video) and collected reports and publications. The team informed interviewees about the purpose of the project and collected consent with a completed and filed form. The team did not use external datasets for the project.

In the preliminary stage, the team also created an anonymous online survey, which was distributed to a small group of potential users to gather initial feedback and insights. In addition, they conducted an extensive literature study and review to ensure that our design choices were based on scientific methodologies and to validate the effectiveness of the proposed solutions within the project.

2.8.2. GDPR compliance

The team ensured the lawfulness, accuracy, and transparency of data management by strictly adhering to data protection regulations. Online interviews were conducted via a self-administered form, ensuring voluntary participation, informed consent, and anonymous handling of responses. For direct interviews and photographs, explicit consent was obtained from participants prior to data collection. Biometric data is not collected; it was processed exclusively within the wearable device in a closed system, making it exempt from data protection regulations. Data regarding soil characteristics are not considered sensitive personal data under current European legislation. In fact, according to the General Data Protection Regulation (GDPR - EU Reg. 2016/679), data protection concerns only information that can directly identify or transmit a natural person. Soil data, being of an environmental nature and not related to individuals, are not included among personal data and therefore are not subject to privacy restrictions provided for by the GDPR.

2.8.3. Relevant ethical issues

The potential ethical issues refer to the collection of biometric data from the user wearing the wearable part of the system. However, as previously explained, these data were used in a close loop and immediately erased.

From the ethical point of view, issues may be associated to the sensorial feedback provided to the user. The translation of soil data to sensorial feedback needs a careful analysis before wide use.

2.9. Soil.AI

Soil.AI is an AI-powered device designed to automate the assessment of soil biodiversity.

2.9.1. Data set

Different real soil samples are prepared and microscope pictures obtained with Microfy's hardware according to different protocols and different objectives.
The use of collected data is restricted to support the data modelling for the commercial product to be distributed in the future.
The data are images to train models. The models are only internally managed. No external used is envisioned yet.

2.9.2. GDPR compliance

There are no relevant issues for GDPR.

2.9.3. Relevant ethical issues

There are no relevant ethical issues related to the future project aimed at soil's analysis.

2.10. Sprouts to flourish

Sprouts to Flourish is an experimental planting generator for agroecology that optimizes biodiversity indexes through scientific metrics.

2.10.1. Data set

The system makes use of the following public data sets:

- FloraVeg European Database (floraveg.eu),
- E-OBS Climate database (surfobs.climate.copernicus.eu/dataaccess/access_eobs.php),
- Climate ADAPT European Database (climate-adapt.eea.europa.eu/en/metadata/indicators),
- Perma People Database (permapeople.org/search),
- Plants for a future Database (pfaf.org/user/).

Curated data on species and the relationships between species, which are based on open public data, will be shared.
The dataset is still undergoing quality assurance, standardisation, and documentation before it can be openly accessed.

Once the data is ready to be published, the team will make it findable by assigning descriptive and relevant metadata, utilizing standardized naming conventions, and depositing the data in accessible platforms with clear identifiers and keywords.

2.10.2. GDPR compliance

The team ensured the lawfulness, fairness, and transparency of the data were managed by adhering to relevant data protection regulations, obtaining necessary permissions for data collection and processing, implementing appropriate security measures, and providing clear and accessible information about how the data is handled. No user data is collected or stored by the current prototype.

No personal data are collected by the system.

2.10.3. Relevant ethical issues

There are no relevant ethical issues associated to the design, development, and use of the system.

2.11. S.O.S – Symphony of Solace

S.O.S is a social companion robot that supports elderly individuals by assisting with nutrition, providing companionship, and helping manage daily routines.

2.11.1. Data set

There are two types of collected data: one from interviews of test users, and data being automatically collected by the robot platforms.

The team also looked at publicly available data like a report from the Swedish Food Agency (Livsmedelsverket) about food recommendations for elderly.

2.11.2. GDPR compliance

The test users were made aware of the data collection and approved it. Before any data would be used publicly it will be anonymized to prevent the data being connected to any person.

2.11.3. Relevant ethical issues

Ethical issues are in the potential collection and use of personal data through the robot. The team has to guarantee full GDPR compliance in the future. Also, addressing a potential vulnerable population, i.e. elderly people, requires a careful analysis of any feedback provided by the robot to the elderly user.

3. Conclusions

While GDPR compliance and anonymization practices are generally well implemented, several projects raise specific ethical considerations:

- **Personal physiological data collection (Neuro-Cooking, Nourish, S.O.I.L., S.O.S):** These projects collect data through sensors. S.O.I.L. explicitly erases data after use, whereas the others anonymize data before storage but lack clarity on potential future uses.
  This uncertainty poses concerns about long-term data governance.

- **Transformation of data into sensorial feedback (S.O.I.L., Nourish):** Presenting soil or EEG data in sensorial or artistic forms raises questions about how feedback may affect users' perception, interpretation, and well-being.
  These impacts need systematic ethical evaluation.

- **Image data collection (BITZ):** Although participants are clearly informed, collecting and processing visual data always carries risks of unintended exposure, warranting ongoing monitoring.

- **Material use (Growing Futures):** While the cultivation process itself poses no immediate issues, ethical considerations will emerge around how the resulting mycelium materials are applied and circulated.

In summary, the key ethical risks relate to the handling of sensitive physiological data, the implications of transforming data into experiential feedback, the responsible management of visual data, and the future use of novel biological materials.