ONE4ALL - Agile and modular cyber-physical technologies supported by data-driven digital tools to reinforce manufacturing resilience

Project nr: **101091877**

D7.7 Report on gender and ethical issues in the ONE4ALL project

Version: 1.0

Funded by the European Union

ONE4ALL project is funded by the European Union under the Grant Agreement No 101091877. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them.

Characteristics of deliverable	
Title	ONE4ALL
Partner	TU Dortmund University (TUDO)
Contributors	All
Short description of deliverable	Report on gender and ethical issues in the ONE4ALL project
Submission date	31/03/2023
Type	Report
Audience	Public
Key words	Ethics, Gender, Diversity

ONE4ALL Key Facts

Acronym	ONE4ALL
Project title	Agile and modular cyber-physical technologies supported by data-driven digital tools to reinforce manufacturing resilience
GA n°	101091877
Starting date	01/01/2023
Duration-months	48
Call (part) identifier	CLIMATE NEUTRAL, CIRCULAR AND DIGITISED PRODUCTION 2022 (HORIZON-CL4-2022-TWIN-TRANSITION-01)
Type of Action	HORIZON-RIA HORIZON Research and Innovation Actions
Topic identifier	HORIZON-CL4-2021-TWIN-TRANSITION-01-03
Consortium	10 organizations, all EU Member States
Model GA type	HORIZON Action Grant Budget-Based

ONE4ALL Consortium Partners

N.	Partner	Acronym	Country
1	IDENER RESEARCH & DEVELOPMENT (Coordinator)	IDE	ES
2	INNOPHARMA TECHNOLOGY	INO	IE
3	CRIT	CRIT	IT
4	EXELISIS	EXE	GR
5	UNIVERSITY OF SOUTHERN DENMARK	SDU	DEN
6	AUTOMATIONWARE	AUTO	IT
7	MADAMA OLIVA	MOL	IT
8	HOLOSS	HOLO	PT
9	TU DORTMUND UNIVERSITY	TUDO	DE
10	ORIFARM	ORI	DEN

Disclaimer

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

Executive Summary

This document deals with the ethical, gender and inclusion principles that are relevant to the implementation of the ONE4ALL project. This is done against the background of the Horizon Europe Framework Programme and related regulations and documents. On this basis, it is explained which measures are taken within the ONE4ALL project so that the principles mentioned can be observed and verified. This deliverable is resulting from Task 7.5 (Ethics & Gender dimensions) of the project.

After an introduction, which establishes the topic and names relevant regulations, the ethical principles of the project work are dealt with (section 2). In particular, the topics of (general) research integrity, data protection and privacy, artificial intelligence, health and safety as well as environmental protection are dealt with. Both the general requirements they contain for (research) work and the specific strategy of the ONE4ALL project to meet these requirements are addressed. Subsequently, the gender and inclusion-related aspects are covered (section 3). Across different work packages and tasks, care will be taken to avoid biases so that the project work and the project result remain open to different groups.

In a concluding section, the general relevance of ethical, gender-specific and inclusion-related principles is first described before a focus is put on the question of how compliance with the principles and the different strategies of the ONE4ALL project can be ensured. Mostly in cooperation with the persons responsible for the respective work packages and tasks, suitable indicators are developed which are continuously applied and evaluated during the course of the project.

Table of contents

List of acronyms

AI	Artificial Intelligence
ALLEA	All European Academies
DG	Directorate-General
DMP	Data Management Plan
DoA	Description of the Action
DT	Digital Twin
FAIR	Findable, Accessible, Interoperable, Reusable
GA	Grant Agreement
GDPR	General Data Protection Regulation
GEP	Gender Equality Plan
HRC	Human-robot collaboration
ICT	Information and communications technology
IPR	Intellectual property rights
ISO/TS	International Organization for Standardization / Technical specification
M5	Month 5 (of the project)
ML	Machine learning
NN	Neural network
RCPM	Cyber-physical production modules
RL	Reinforcement learning
RRI	Responsible Research and Innovation
SHELLO	Software-Hardware-Environment-Liveware-Liveware-Organization

List of figures

List of tables

1. Introduction

This report outlines how ethical, gender-specific and inclusive principles will be observed during the implementation phase of the ONE4ALL project. To meet recognised standards, the project will connect to a number of frameworks, regulations, and documents and derive concrete indicators and procedures for their compliance. The report will be updated continuously and will also be the blueprint for a project-internal seminar, to be held in M5 of the project.

In addition to compliance with legal requirements, the Horizon Europe Framework Programme, which funds the ONE4ALL project, is the most important reference. Its Programme Guide commits the funded project to address both gender and ethics and already provides concrete guidelines and standards to do this [1].

Ethics has a dedicated chapter in the Framework programme [1, pp. 21-26]. It is depicted as an "integral part of research from beginning to end, and ethical compliance is seen as pivotal to achieve real research excellence" [1, p. 21].

Within the ONE4ALL research project, human-and-sustainability-centred plug-and-produce reconfigurable cyber-physical production modules (RCPMs) will be developed (consisting of cobots, IIOT devices and AI-based decision support systems). Related to this approach, the ethical sub-aspects of research integrity, data protection and privacy, health and safety, environmental protection as well as trustworthy artificial intelligence are of particular importance. Some of these criteria are already directly addressed within the impact assessment or other parts of ONE4ALL, e.g., Health and safety (T1.1) as well as Environmental protection and societal aspects (T1.2) and Data privacy and protection (T7.2). As overarching themes, however, they will also be taken up and dealt with in the other work packages, especially in those dealing with technological developments.

Important further sources include *The European Code of Conduct for Research Integrity* published by ALLEA - All European Academies [2], the *Ethics Guidelines for Trustworthy AI* [3] as well as the European Commission's report on *Ethics and data protection* [4].

The topic of gender and inclusiveness is a further focus of this document. The European Code of Conduct for Research Integrity refers to the relevance of this topic by emphasising that "Research protocols take account of, and are sensitive to, relevant differences in age, gender, culture, religion, ethnic origin and social class". Moreover, "open and reproducible practices in hiring and promoting" should be used [2, p. 5].

Also, the Horizon Europe Framework programme contains a subsection on Gender equality and inclusiveness [1, pp. 14-19]. Funded projects should accordingly address the issue on three levels: By the organisations involved drawing up a Gender Equality Plan (GEP), by integrating the "gender dimension into research and innovation content", and by reaching a Gender balance among the team members [1, pp. 14-15]. Within the ONE4ALL project, a special relevance of the gender topic arises due to the below-average representation of women in industrial, engineering and ICT sectors as well as in academia (as outlined in section 3.2).

Both the Gender and the inclusion topics are considered systematically and continuously. The focus is on a gender-neutral approach and design. Relevant further important sources include the results of the Gendered Innovation project [5] as well as the *Toolkit Gender in EU-funded research* [6].

In this report, we will go into detail about the implementation of the ethical, inclusive and gender standards within the project. We will especially extend on ethics in scientific research and publications and technical, ethical aspects (chapter 2) as well as the topics of gender and inclusion

(chapter 3). Finally, in chapter 4, we will outline how the most relevant aspects will be dealt with in the course of the project and how their observation can be secured.

2. Ethics

2.1. Ethics in scientific research and publications

Ethical issues are of high importance for EU-funded projects under Horizon Europe, as pointed out in the programme guide for Horizon Europe: "all research activities carried out under Horizon Europe are conducted in compliance with fundamental ethical principles." [1, p. 21].

Ethics is a mandatory section in the development and evaluation of project proposals and is also integrated into the ONE4ALL proposal (1.2.5 Gender and ethics dimension [7, DoA - Part B, p. 20] & 4. Ethics self-assessment [7, DoA - Part B, p. 40]). Article 14 of the Grant Agreement (GA) refers to annexe 5 of the proposal, which clearly points out the demands for ethics: "The beneficiaries must pay particular attention to the principle of proportionality, the right to privacy, the right to the protection of personal data, the right to the physical and mental integrity of persons, the right to non-discrimination, the need to ensure the protection of the environment and high levels of human health protection. […] In addition, the beneficiaries must respect the fundamental principle of research integrity — as set out in the European Code of Conduct for Research Integrity." ([7, specific rules, pp. 1-2], see also European Code of Conduct for Research Integrity [2]). While some ethics assessment is already completed during the development of the proposal and the grant agreement, the programme guide for Horizon Europe also includes specific measures for addressing ethical issues during the implementation phase. Here, ethics reviews, checks or audits are required, e.g., by reviews of project deliverables or by interviews or site visits. While this project, ONE4ALL, is not dealing with specific ethical issues, such as the use of human embryonic stem cells, there are few references to specific ethics issues relevant to ONE4ALL, e.g., Ethics for trustworthy AI (s. section 2.2). Therefore, these specific issues have to be identified in this deliverable and updated further during the project. As a starting point, five issues are identified, which are covered by the Ethic Review during proposal evaluation and seem to be relevant for ONE4ALL[1]. These are:

a. research integrity
b. data protection and privacy
c. artificial intelligence
d. health and safety
e. environmental protection

Research Integrity (a), as regulated in the European Code of Conduct, provides a generally applicable framework to be taken into account in research projects. Therefore, these general principles should already be considered in developing proposals by transferring them into work packages and tasks. How research integrity is implemented is then documented in deliverables, and compliance is checked in the reviews. Research Integrity overlaps with other ethics and gender issues, which we discuss separately in the following sections. These are more specific and will be elaborated/adjusted during the project duration, and their compliance will be checked across all work packages, tasks and deliverables. They cannot be dedicated to specific deliverables but are guidelines for the whole project. Therefore, we address these issues separately here.

Specific topics within these ethical issues will be transferred into checklists (s. section on Conclusions and Actions) which will be used for ethical reviews during the run of the project.

[1] Further issues of the Ethics Reviews, such as human rights and protection of human beings and animal protection and welfare, are dropped here as they are not affected by the ONE4ALL project.

2.1.1. Ad a) Research integrity

For general research integrity, The European Code of Conduct for Research Integrity, published by ALLEA - All European Academies [2], is an important source.

The Code of Conduct entails central, four overarching principles of research integrity and their realisation in eight contexts. Within the ONE4ALL project, the guidelines of the Code of Conduct will be followed.

The four research principles are described as follows [2, p. 4]:

- "Reliability in ensuring the quality of research, reflected in the design, the methodology, the analysis and the use of resources.
- Honesty in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair, full and unbiased way.
- Respect for colleagues, research participants, society, ecosystems, cultural heritage and the environment.
- Accountability for the research from idea to publication, for its management and organisation, for training, supervision and mentoring, and for its wider impacts."

The eight contexts of the realisation of research integrity are [2, pp. 5-7]:

- Research Environment
- Training, Supervision and Mentoring
- Research Procedures
- Safeguards
- Data Practices and Management
- Collaborative Working
- Publication and Dissemination
- Reviewing, Evaluating and Editing

The Code of Conduct addresses both the researchers and the institutions behind them. The measures include requirements for infrastructure and organisation, research-related quality, ethics, collaboration as well as the handling of data and results, both with regard to their safekeeping and their publication.

The ONE4ALL consortium works along the dimensions of research integrity identified in the Code of Conduct. The different aspects are addressed in different parts of the project:

- The Code of Conduct stresses the importance of an open and transparent publication of results (Context "Publication and Dissemination"). The ONE4ALL project follows an open access strategy (which is described in sections 1.2.6 and 1.2.7 [7, DoA - Part B, pp. 20-22], also T7.2 [7, DoA - Part A, p. 15]) and includes a KPI that requires realise a minimum of 25 Open Access publications and 30 dissemination events.
- The Code of Conduct also stresses the importance of reviews and corrections for research (Context "Reviewing, evaluating and editing"). In the ONE4ALL project, a fixed review process is organised (as described in T7.3).
- The Code of Conduct also demands that "Researchers recognise and manage potential harms and risks related to their research" [2, p. 6]. This is taken up by the risk assessment of the project (addressed in T7.4).
- Furthermore, the Code of Conduct includes principles on Collaborative working and requires transparent, timely communication – which is facilitated by the Sharepoint Platform the project uses (s. T7.4) as well as the general coordination of the project (as pointed out in T7.1).

- Finally, the Code of Conduct requires a "proper and conscientious use of research funds", which is taken up by the financial administration of the project (described in T7.4).

Further elements mentioned in the Code of Conduct are also taken up by the project: The backgrounds of data protection and privacy, health and safety, and environmental protection will be explained in the following sections.

2.1.2. Ad b) Data protection and privacy

In a guidance note of the European Commission (DG Research & Innovation), data protection is considered a "central issue for research ethics in Europe and a fundamental human right" and must, therefore, "be rigorously applied by the research community" [4, p. 4]. That means that EU-funded research projects processing personal data must not only comply with the EU (esp. the General Data Protection Regulation - GDPR) and national data protection laws but should be guided by ethical values beyond pure compliance. Artificial intelligence used in the ONE4ALL project deserves special attention as it implicates higher risks on data subjects. This is specifically required if the related project is processing personal data – which will be the case in ONE4ALL when interviews will be carried out. Personal data are those that are related to an identified person but also to an identifiable person [8, Article 4(1)]. Therefore, it has not only to be ensured that names of persons are linked to connected data but also that data cannot be related to a person, e.g., by combining different data (big data, AI etc.). Special attention has to be paid to special categories of personal data "revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and the processing of genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation'" [8, Article 9(1)].

The recommended way to deal with ethical issues on data protection is to anonymise or pseudonymise data. If data are no longer related to identifiable persons, they are not personal data and have not to be dealt with along data protection law [4, p. 8]. If for research purposes, it cannot be avoided to keep links between the research data and the personal data, then these data should be pseudonymised in order to minimise risks for the persons involved. If there is a "significant prospect of re-identification", the data should be treated as personal data. It is recommended to "err on the side of caution" [4, p. 9].

GDPR requires "data protection by design", which means designing systems, databases and processes (by technical and organisational measures) that comply with the fundamental rights of data subjects (such as anonymisation/pseudonymisation, data minimisation etc.; [4, p. 10]). Furthermore, data protection should be enhanced "by default" instead of as an extra option.

Informed consent is considered "the cornerstone of research ethics" [4, p. 11]). Whenever personal ata from research participants are needed, it is required to explain to them what the research is about, what the role of the participants will be and what risks this entails (along with GDPR standards). The Commission's guideline on Ethics and Data Protection points out what has to be included in the consent form (e.g., if data are transferred to research partners, how long data will be stored etc.; [4, p. 12].

Specific attention has to be paid to big data (and similar ways of processing data), which allows combining and analysing different datasets leading to potentially unforeseen consequences for individual data subjects, communities and society. If these techniques are used, a detailed analysis of the ethical issues raised by the technologies is needed.

Within the project ONE4ALL, data protection/data processing is addressed in the Grant Agreement, in which the consortium has assured a procedure that complies with national and international laws and regulations. Especially the following aspects are relevant:

- The data processing must be transparent to the data subjects;
- The data processing has to be data-saving, i.e., the data has to be connected to a specific purpose, and the identification of persons should only be possible for as long as necessary;
- The data itself has to be accurate and, where necessary, up to date;
- The data has to be processed in a secure way.

Task 7.2 includes a Data Management Plan, which ensures that all data are "gathered under FAIR premises, data protection and IPR" [7, DoA, Part A - p. 15]. FAIR means that data are Findable, Accessible, Interoperable and Reusable.

2.1.3. Ad c) Artificial Intelligence

As Artificial Intelligence will be used within the ONE4ALL project, ethical issues of trustworthy AI will be considered. This will be done within the following section on Ethics in Technology, including the definition and classification of AI, characterisation of AI-based elements used within ONE4ALL and requirements for an ethical AI (→ Trustworthy AI Assessment List for the ONE4ALL Project).

2.1.4. Ad d) Health and Safety

According to the European Code of Conduct for Research Integrity, researchers have to ensure that the safety and health of all those associated with the project are not endangered. This does include not only physical health but also mental health. In the project, health and safety are relevant issues for the collaboration of humans with robots (cobots).

Basically, different types of collaborative robots have to be considered from a separation by a protective fence (separate workspace - contact possible) to a partially shared workspace (used by humans only when the robot is stopped) and a shared workspace that needs or requires contact between humans and robots to perform the work task. Therefore, the main difference between traditional and collaborative robots is the direct interaction with humans.

The Description of Action includes that the safety of humans has to be fully ensured, while the impact on cobots´ efficiency should be minimised. However, human safety is always to be prioritised.

When using cobots in the form of a shared workspace, the first thing to focus on is safety. Since these robots are in direct interaction with humans and do not come with any physical protective measures (fencing, robot cells), they can easily injure humans or influence them in other ways. Cobots in direct contact with humans (Human-robot –collaboration systems) are, therefore, already limited in their technical design (maximum force, sensor technology) in order to be able to prevent such risks. Basically, technical safety for humans is regulated in ISO/TS 15066 - Robots and robotic devices - Collaborative robots. The standard describes four basic principles [9]:

- Safety-rated monitoring stop
  - Movements by the robot are only possible when the human is outside the workspace. However, contact is possible in principle.
- Speed and separation monitoring
  - Here, the human can enter the workspace, and the robot can adjust its speed based on defined distances from the human.
- Hand guiding
  - Direct contact is necessary here. The human guides the robot in the shared workspace in order to demonstrate the work task.

- Power and force limiting
    - In this case, a common workspace is defined, which the robot and the human use simultaneously during the work task.

But when considering cobots, it is not only the pure safety analysis or physical safety that needs to be taken into account. There are also questions about mental health. The question of how to deal with cobots and their effect on employees is central but has so far been perceived almost exclusively in technical terms in current research. There are countless studies on physical health, but only a few on mental health. Nevertheless, this topic has recently received more attention, which is also reflected in a higher number of research results and studies on the topic of mental health [10].

When considering Human-robot collaboration (HRC), it seems to be helpful to broaden the often technically-centred perspective in favour of a more socio-technical view. In this way, also mental health problems can be taken into account [10].

Current research on this socio-technical perspective shows that using the so-called SHELLO (Software-Hardware-Environment-Liveware-Liveware-Organization) model, the socio-technical idea can be integrated, and the risks can be reduced. “This may help to overcome the traditional techno-centric approach to HRC, focused mainly on physical and safety-related aspects and less on the implications related to the nature of the collaborative work, where the “co-agency” is the unit of analysis” [10, p. 431]. That means that the collaboration is precisely at the core of the analysis (instead pure technical impact of the cobot). This has to be added to the technical and ethical aspects pointed out in section 2.2.

Within task 1.1, new standards and protocols of workforce safety will be defined by Automationware and TU Dortmund University. Therefore, the requirements on safety and health as an ethical issue will be specified afterwards and will be the subject of the next update of deliverable 7.7 (which is considered a living document that will be updated as soon as new insights arise which are related to ethical issues).

2.1.5. Ad e) Environmental protection

The project ONE4ALL is dedicated to Industry 5.0 solutions. As sustainability is one of the three key dimensions, substantial contributions to environmental protection are to be expected. According to the Description of Action (Part B), it is ONE4ALL´s ambition to implement a human and environmental-centred approach [7, DoA - Part B, p. 5]. More detailed, the DoA includes the ambition that “the environmental sustainability outcomes focus mainly on resource optimisation, energy efficiency and footprint reduction. ONE4ALL will address a complete mapping of the energy consumption of the RCPMs and the resource consumption of the activities handled by those.” [7, DoA - Part B, p. 12]. In principle, current data should first be recorded (status quo) in order to be able to determine a starting point. Subsequently, possible savings potentials are to be presented and addressed in the further course of the project. This is addressed in work package 1 on Human and Sustainability Impact Assessment, including Task 1.2 (Life Cycle Sustainability Assessment tool), Task 1.3 (Resource consumption monitoring and optimisation tool), and Task 1.4 (Digital maturity & Sustainability assessment module). Results will be presented and reviewed in deliverables 1.5 – 1.11.

2.2. Technical ethical aspects

In projects like ONE4ALL, which belongs to Industry 5.0, the importance of the technical, ethical aspects increases due to the development of sustainable and human-centric solutions. In addition, if AI-based tools and cobots are part of those solutions, the ethical aspects become crucial. This section addresses their definition in relation to AI and the health and safety considerations, which must be taken into account from the initial design of the solutions to their installation in the industrial facilities.

According to the High-Level Expert Group on Artificial Intelligence [11] "Artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely software-based, acting in the virtual world (e.g., voice assistants, image analysis software, search engines, speech and face recognition systems) or AI can be embedded in hardware devices (e.g., advanced robots, autonomous cars, drones or Internet of Things applications)." From this definition, it can be deduced that the field of AI is very broad and complex, so a specific description cannot be made. In an attempt to classify AI algorithms, the High-Level Expert Group on Artificial Intelligence [11] distinguishes between those algorithms focused on reasoning and decision-making, such as knowledge representation and optimisation algorithms, and those focused on learning, basically machine learning (ML). To the latter group belong branches such as neural networks (NN) and reinforcement learning (RL). In addition, a third group is distinguished as part of AI, although increasingly independent, such as robotics. In ONE4ALL, we will work mainly with the latter two groups, **machine learning** and **robotics**.

The implementation of AI solutions has exponentially increased in the last decade, especially in the manufacturing sector. Under the framework of the Horizon 2020 Programme, some projects, such as STAR (Safe and Trusted Human Centric Artificial Intelligence in Future Manufacturing Lines) and COALA (Cognitive Assisted agile manufacturing for a Labour force supported by trustworthy Artificial Intelligence), deal with the ethics and safety of AI-based solutions in manufacturing. Indeed, the European Commission published a report, *Ethics guidelines for trustworthy AI* [3]. This report presents the baselines of the trustworthiness of AI and the requirements to develop trustworthy AI-based systems. According to it, trustworthy AI should be lawful, complying with all applicable laws and regulations; ethical, following ethical principles and values; and robust, both from a technical and social standpoint, as AI systems have the potential to harm people even if they have the best of intentions.

Although the lawfulness of AI applications is not addressed in detail in the report [3], it can be assumed that such applications cannot escape the law. They must comply with several treaties and regulations at the international, European and national levels, including the EU primary law and the EU secondary law. These laws also implicitly include some guidance related to the development of an ethical and robust AI. In addition, the development of trustworthy AI is based on 4 ethical principles based on fundamental rights: i) respect for human autonomy, which means that the AI system must guarantee the full and effective determination of humans and human supervision must prevail; ii) prevention of harm, implying safe and secure and technically robust systems; iii) fairness, avoiding any kind of bias; and iv) explainability, encouraging the transparency of the processes.

These fundamental principles must be translated into practical requirements for the realisation of trustworthy AI. These must be assessed during the whole life cycle of the AI system by all agents involved in it, for which technical and non-technical methods can be employed. These requirements are listed below.

1. Human agency and oversight, including fundamental human rights.
2. Technical robustness and safety, such as assault resistance, security, a backup plan, general safety, precision and reproducibility.
3. Privacy and data governance, including the quality and integrity of data, data access and respect for privacy (s. also requirements on data protection and privacy in section 2.1).
4. Transparency, which involves communication, explainability and traceability.
5. Diversity, non-discrimination and fairness, avoiding unfair bias, promoting accessible and universal design, and involving stakeholders (s. also more specific aspects of gender and inclusiveness in section 3.1).

6. Societal and environmental well-being, encompassing environmental friendliness, social dimension, and society and democracy.
7. Accountability, including auditability, minimising negative effects and disclosing them, making trade-offs, and seeking redress.

From a practical point of view, the document *Ethics guidelines for trustworthy AI* presents an assessment list[2] to measure the trustworthiness of AI. This list contains a set of questions that are mainly addressed to developers and deployers of the AI system. These questions must be adapted to the context of the AI system implementation, and they are focused on evaluating the ethics and robustness of AI. Lastly, it should be highlighted that this assessment list does not certify the trustworthiness of AI, but it provides valuable guidance to ensure compliance with applicable law and ethical principles. This assessment list will be reviewed as the AI systems develop, which will be updated in the following deliverables.

Regarding the health and safety aspects of the AI and robotic systems to be developed in the ONE4ALL project, they will be deeply explained in the corresponding deliverables. Especially the implementation of cobots in factories is a critical point in relation to the safety of workers, as they will perform tasks together, and the risk of injury is higher. Given the trend in the use of this type of robot in recent years, the European Commission has launched several research projects related to this issue. A clear example of this is the COVR project (Being safe around collaborative and versatile robots in shared spaces), the results of which are expected to be used throughout the ONE4ALL project. Among these results, we highlight the standards, protocols and risk assessment according to the types of robots and their applications (s. also more general requirements pointed out in section 2.1).

3. Gender & Inclusion

3.1. Inclusion & diversity

Inclusion and diversity are central themes in ONE4ALL. Scientific research should be designed to be as non-discriminatory as possible. There are many risks of discrimination, the most prominent of which are factors such as gender, skin colour and race. In addition, however, many other such risks are conceivable, such as educational background, religion, and physical or mental disabilities, to name but a few. In addition, there are risks of linking such discriminatory factors, whose mere subsumption under the term gender falls short. For example, dark-skinned women may well have to struggle with physical disabilities. A pure focus on gender does not go far enough. However, non-discriminatory research also means that research should be designed in such a way that all stakeholders are broadly involved. Only then can one speak of the actual inclusion of all stakeholders in the research process.

In order to do justice to the basic idea of open and non-discriminatory research, ONE4ALL uses an intersectional approach which means considering intersections of different discrimination factors. This approach allows us to recognise different, interdependent and intersecting axes of people's social identity (e.g., gender, age, unemployment etc.). This is significant because one factor, such as gender, does have a formative effect on other characteristics (e.g., unemployment) and is shaped by them. Thus, this approach enables a simultaneous consideration of different discrimination factors (intersections) and takes them into account. In this way, a purely additive view of these factors can be broken up, which would only lead to further discrimination through a one-dimensional view (only women, only migrants, etc.).

[2] It is included in Chapter III of the document Ethics Guidelines for Trustworthy AI (https://data.europa.eu/doi/10.2759/346720)

This avoids one-sided definitions in the development of hypotheses and the specification of a research design. The ONE4ALL consortium represents different areas of research in order to gain a broad view and access to the direct research questions within the framework of joint optimisation. The interdisciplinarity in the consortium supports the inclusion of all possible factors through a constant exchange.

An intersectional approach supports a broad perspective and leads to greater inclusion of the groups involved, as it systematically includes consideration of discrimination factors in the research process. Basically, we can proceed along the following phases of research [5].

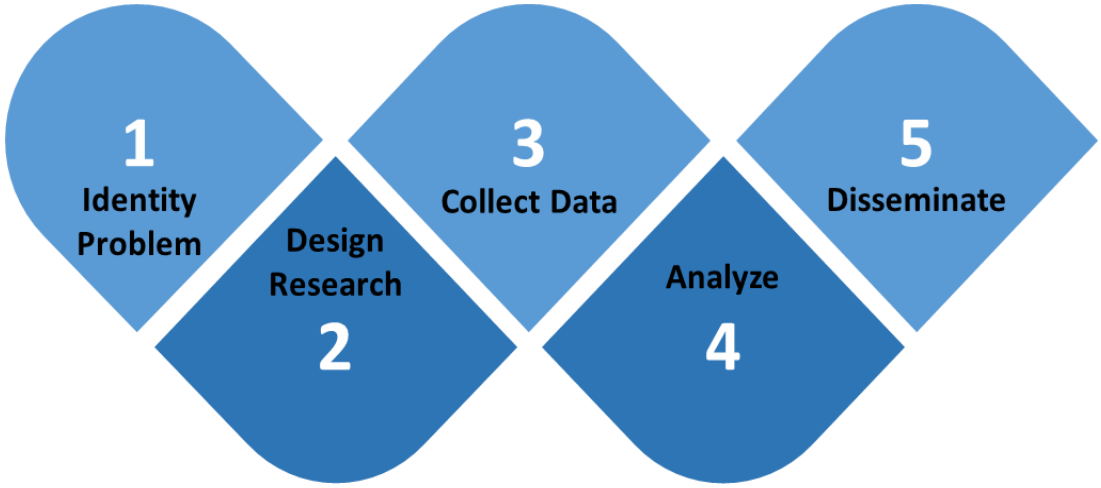

Figure 1: Intersectional Approach. Own illustration based on [12]

These phases essentially describe individual steps in the context of research projects, from identifying the problem to collecting data and disseminating the results. With the design of these steps (Figure 1) in the sense of an intersectional approach, a recording of possible discrimination factors is made at each individual step. In addition, all phases of the research are designed to be as open, diverse and inclusive as possible in the respective phase through the analysis of discrimination factors. In ONE4ALL, a checklist of possible discrimination factors will be created and continuously reviewed.

Following this approach of including non-discrimination in any research phase leads to diversity and inclusiveness ***by design***. In this way, not only can the actual research result be improved, but also a broader basis of acceptance for this research can be created.

3.2. Gender

3.2.1. Gender equality as a cross-cutting issue in Horizon Europe

The Horizon Europe programme of the EU addresses the issue of gender equality as a cross-cutting theme [13]. This was already taken into account in the annexe of the framework programme by including an extra article on gender equality. Furthermore, the programme has committed itself to reduce gender inequality in research projects and, in particular, promoting women's scientific careers. In order to be able to take this cross-sectional idea into account, the following points, in particular, are addressed [1, pp. 17-18]:

- "**Reflect on why sex and/or gender could matter:** Think about and present the ways in which taking into account the gender dimension will provide added value in terms of creativity, excellence, and return on investment, both from public and private perspectives.
- **Consider the production of new knowledge on gender:** Consider what is already known in your area in terms of the gender dimension (*e.g., related scientific literature*) and identify what is missing. In many areas, gender knowledge still needs to be generated.

- **Include sex and gender aspects as part of a multidisciplinary approach:** Reflecting on sex and gender considerations in relation to health, transport, energy, security, etc., is a great opportunity to foster cooperation between scientists with gender expertise and others. It helps concepts cross the borders of scientific fields and encourages research methods to evolve.
- **Consider social categories/factors intersecting with sex and gender:** the way a research problem is formulated will determine which intersecting variables are relevant for analysis. Intersectional research should be designed to illuminate the multiplicative effects of different but interdependent categories and factors."

The involvement of women promises to increase the quality of results in research and development. This also leads to a broader acceptance of postulated results, as a one-sided view can be avoided, and further parts of society can be represented. This also makes it clear that with a non-gender-neutral view, significant parts of society are left out, which leads to suboptimal (economic) results. Therefore, gender-equal teams are more suitable, especially to avoid blind spots caused by too one-sided considerations.

However, women are still underrepresented if one looks at current figures from the European Commission [14]. With regard to higher academic degrees, it can at least be stated that parity has been achieved in doctoral degrees across the EU. Nevertheless, further gender gaps remain to be filled. For example, doctoral degrees in mechanical engineering, technology and construction continue to be male-dominated. But other key figures also indicate that parity between women and men has not yet been achieved. Some important key figures are listed here [14]:

The proportion of women in grade A positions: within the EU-28 in 2015, 24.3 %. In 2018, 26.2 %.

- The proportion of women as heads of institutions in the higher education sector: within the EU-28 in 2014, 20.1 % of the heads of institutions were women. In 2019, this increased to 23.7 %.
- The proportion of women as heads of institutions accredited to deliver PhDs: the EU average was 15 % in 2014. Actual data shows an increase of up to 18 %.
- The proportion of women on boards: increased from 28 % in 2014 to 31 % in 2019.

These data make it clear that, in some cases, great progress has been made in involving women in the relevant areas. Nevertheless, it is also clear that in many cases, the gender gap is still quite large and further efforts need to be made to close these gaps.

Building on the initial results of other projects, it can be assumed that gender can be a central element of Responsible Research and Innovation (RRI) [15–17] and thus promote not only inclusive but also sustainable innovation. It can be concluded from this that RRI can be seen as a broad approach that not only enables a gender perspective but also brings together different actors in the sense of social innovation. In this way, broad involvement of the actors concerned can be ensured, which significantly increases the acceptance of the results and thus supports the dissemination and use of the innovation.

3.2.2. Gender balance in decision-making

Increasing the number of women in leadership and decision-making positions is and remains a long-term goal that should be pursued. Only in this way can decision-making processes run optimally in the best sense and combine the different perspectives. Unfortunately, decision-making positions in particular (both in research and in business) are still occupied by a majority of men, which can be counterproductive to the outcome of the decision. Moreover, such decisions may appear less accepted or even disturb social peace.

There are different recommendations across the EU for promoting women in leadership and decision-making positions. On the one hand, it is argued that fixed quotas should be laid down in law. On the other hand, greater promotion of women by women is being considered.

However, it should be noted that increasing the visibility of women who are already working in such positions can contribute to the further pursuit of this goal. In this way, (young) scientists can be encouraged to want to take on such tasks.

Excluding women from decision-making positions will lead to poorer decisions in the long run, which can hardly be in the interest of institutions or companies. First steps can be taken here through boards and committees with equal representation of women and men—for example, a gender-equal composition of national governments.

3.2.3. Gender in research content

The share of women in science and engineering is currently around 41%. This means that about 6.6 million women are employed in this sector across the EU. However, if one looks deeper into the sectors, the picture is somewhat different. In the manufacturing sector, for example, only about 22 % of employees are women [18].

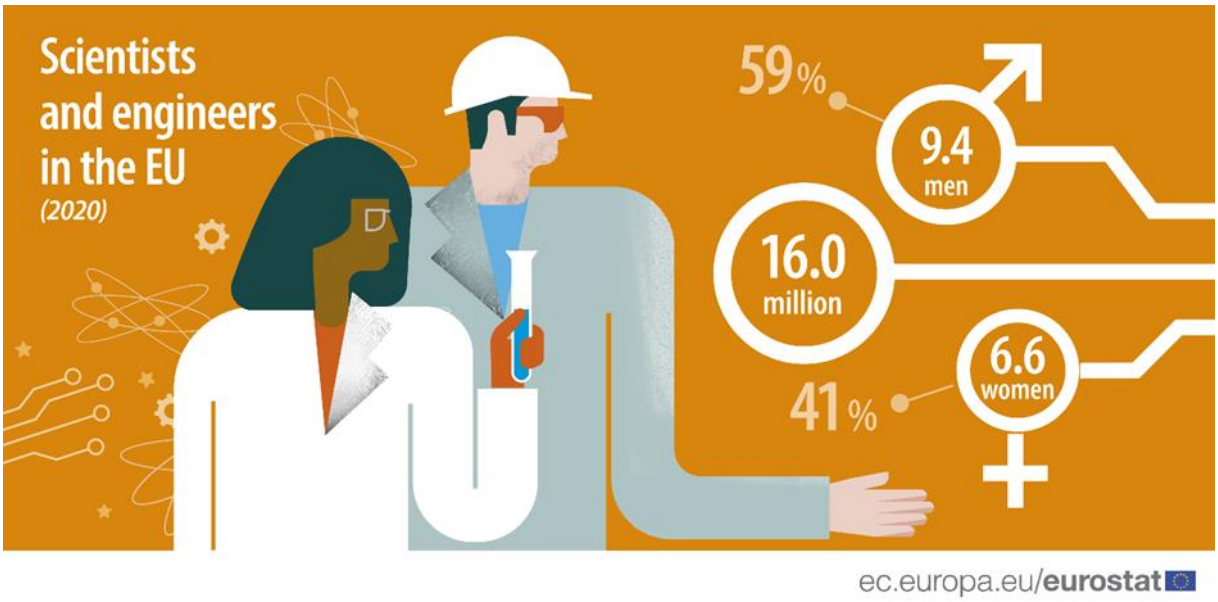

Figure 2: Scientists and engineers in Europe. Source [18]

Since the manufacturing sector is a very important sector in the EU, it is also important to increase the proportion of women in this sector. This is particularly important in view of the fact that this sector seems to be at a crossroads. Sustainability, digitalisation and decarbonisation are challenges that this sector is facing in particular. The sector cannot afford to do without talent - regardless of gender - due to the immense challenges. It is, therefore particularly important to continue to work on a stronger involvement of women, as this will allow new perspectives and more diversity to flow into the necessary change processes.

According to current data (2021), the share of women in the ICT sector is 15.9 %, which is even lower than in 2020 [19]. The increasing share of digital technologies and applications in all areas of value creation will further increase the demand for specialists in this field. Therefore, the observed decline of women in this field is particularly significant. A stronger involvement of women can do more justice to this demand and also support the desired equal distribution of women and men. In addition, a stronger involvement of women can lead to considerable potential in the field of ICT being raised.

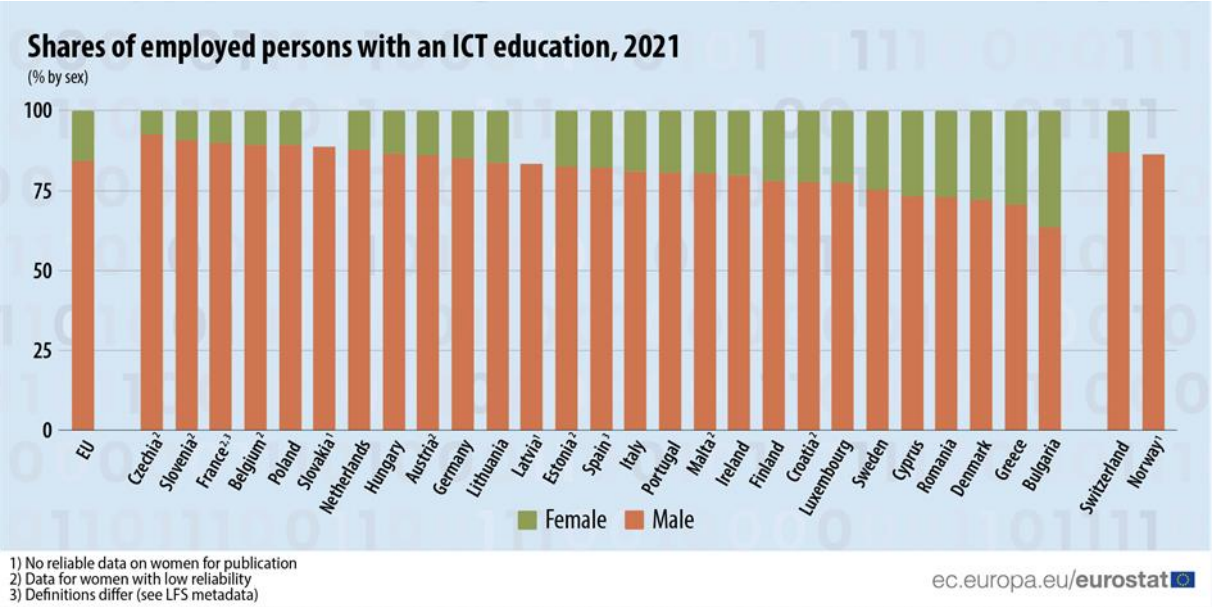

Figure 3: Employment ICT. Source: [19]

3.2.4. Gender balance in the consortium

In the ONE4ALL project, all partners commit to balanced staffing. In addition, all partners also have their own national guidelines to avoid discrimination against women. Currently, the project consortium is structured as follows with regard to the distribution of women and men:

Partner	Female	Male
Idener	1	4
Innopharma	4	5
CRIT	2	2
EXELSIS	1	2
SDU	3	2
AUTOMATIONWARE	4	8
MADAMA OLIVA	1	2
HOLOSS	1	1
TUDO	0	2
Orifarm	0	3
Total	17	31

Table 1: Gender in the consortium.

At the start of the project, 35% of the project staff are women.

Conclusion and actions

Cross-cutting themes, gender and ethics are essential cornerstones of the Horizon Europe Programme. Especially in the context of research and development, these topics are currently and will be of great importance in the future. Research Integrity is needed to ensure the trust of stakeholders in research results and the solutions that are being developed. To consider gender and diversity issues is required to represent different groups in business and society. It is targeted by EU policy and research programmes to leave nobody behind and to aim at providing benefits to all, including groups disadvantaged on the labour market such as elderly people, migrants, low-skilled and unemployed people. This leads to more fairness in European societies and mitigates the lack of skilled workers.

However, the reality is still different. Women are still underrepresented in many technical fields (mechanical engineering, ICT), which may already seem inexplicable, especially in view of the resulting loss of possible solutions to technical problems. At the same time, this also drives a development that does not represent the full range of potential users in the actual development process, which in turn can lead to user reservations or undesirable developments.

On the other hand, current approaches such as Industry 4.0 produce advanced technologies which have far-reaching effects on work (jobs, job tasks, skill requirements) and society (digitalisation of health, administration, social life). Particularly the handling of data, technologies and advancing digitalisation influences not only research but also the everyday life of employees in almost all areas. As a result, the personal data of users is increasingly becoming part of the value creation process ("data as a currency"), which makes it necessary to pay special attention to data protection and privacy and to avoid or mitigate unintended developments. In addition, employment and the content of employment are changing significantly as a result of digitalisation. This results in different or new job profiles that are placed on employees. A concentrated consideration of these developments is necessary to influence these developments towards gender and ethical wishful direction.

This mix requires a special approach to technology from the moment it is introduced. Developers, employees, users and end customers should be more and more involved in the development process. Women (with dependent children) and other relevant groups disadvantaged on the labour market should be considered and involved as far as possible to ensure that everybody can benefit from new solutions. That means that both technological and social innovations are a means to an end, namely achieving value for business and society. While developing technologies and new social practices, their impact on gender and ethical issues should always be taken into account.

Therefore, ethical principles must be applied to research into and the introduction of new technologies. Thus, with clearly defined and accessible ethical principles, trust in research results can be increased, as the research results can be reviewed along these principles. At the same time, ethical principles such as explainability and transparency [20] also enable trust in new digital technology to be created or increased.

The ONE4ALL project uses a wide range of technologies to test their use in two use cases. The focus is on the development and use of human-and-sustainability-centred plug-and-produce RCPMs in the use cases, which, however, entail a variety of other technologies (cobots, digital twins, AI-based decision support systems). These technologies have a significant impact on job profiles, skills requirements and the well-being of affected employees on site, which have to be considered. At the same time, they must be designed in such a way that no discrimination can be created or perpetuated in the use cases and beyond by the technologies to be introduced.

With the present Deliverable 7.7, ONE4ALL has faced up to these prerequisites and made it clear that these issues are of great importance on the one hand and on the other hand, made it clear how these issues can or will influence the project. In order to ensure compliance with the gender and ethical issues presented above in the practical implementation of the project and the use cases, different measures are being taken.

Table 2 (see following page) provides an overview of the individual measures in the further course of the project.

In addition to the measures presented here as an overview, adapted and manageable checklists will be drawn up as the project progresses to simplify the consideration and integration of the contents presented here in practical implementation. In addition, a webinar will be held in M5 with all project partners, which will explain the contents presented here and provide the opportunity for reviewing the gender and ethical issues according to the needs of the project.

ONE4All will thus achieve that the topics of gender and ethics are applied and understood throughout the project as cross-cutting issues already understood in this way by the Framework Programme (Horizon Europe).

Area	Related principles	One4All	
		Measures	Indicators
Making aware of Code of Conduct and research principles	"Research institutions and organisations demonstrate leadership in providing clear policies and procedures on good research practice and the transparent and proper handling of violations." [2, p. 5] "Research institutions and organisations develop appropriate and adequate training in ethics and research integrity and ensure that all concerned are made aware of the relevant codes and regulations." [2, p. 5]	Organisation of a workshop to inform partners on standards in Ethics and Gender within the project (T7.5)	Workshop has been held
		Writing of a report, which will be regularly updated (T7.5)	Publication of the report and its updates
Data protection + privacy	"Research institutions and organisations support proper infrastructure for the management and protection of data and research materials in all their forms (encompassing qualitative and quantitative data, protocols, processes, other research artefacts and associated metadata) that are necessary for reproducibility, traceability and accountability." [2, p. 5] "Researchers, research institutions and organisations ensure appropriate stewardship and curation of all data and research materials, including unpublished ones, with secure preservation for a reasonable period." [2, p. 6]	Set up of Data Management Plan (D7.8) in M12, M24, M36 (T7.2)	The data management plan will be reviewed along the criteria on data protection and privacy of the guideline on ethics and data protection mentioned in section 2.1.1.

Gender **Diversity & Inclusion**	"Research institutions and organisations reward open and reproducible practices in hiring and promotion of researchers." [2, p. 6]	Monitoring of Gender Balance (T7.5)	A preliminary checklist will be adapted to the project needs to review or consider the relevant points.
	"Research protocols take account of, and are sensitive to, relevant differences in age, gender, culture, religion, ethnic origin and social class." [2, p. 6]	Monitoring of Research approach (T7.5)	A preliminary checklist will be adapted to the project needs to review or consider the relevant points.
Environmental protection	"Researchers handle research subjects, be they human, animal, cultural, biological, environmental or physical, with respect and care, and in accordance with legal and ethical provisions." [2, p. 6]	Development of a Life Cycle Sustainability Assessment tool (T1.2)	To be developed in conjunction with T1.2.
		Resource consumption monitoring and optimisation tool (T1.3)	Reduction of CO2 emissions. To be developed in conjunction with T1.3.
Health & safety	"Researchers have due regard for the health, safety and welfare of the community, of collaborators and others connected with their research." [2, p. 6]	Definition of safety protocols for human-robot collaboration (T1.1)	To be developed in conjunction with T1.1.
Artificial Intelligence	*Not explicitly dealt with in the Code of Conduct*	Ensure application of EU's Guidelines on Trustworthy AI (T3.2)	To be developed in conjunction with 3.2.

Table 2: Relation of ONE4ALL measures and indicators to principles of research integrity.

References

[1] European Commission, "Horizon Europe (HORIZON): Programme Guide," Version 2.0, 2022. [Online]. Available: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/programme-guide_horizon_en.pdf

[2] ALLEA - All European Academies, The European Code of Conduct for Research Integrity: Revised Edition. Berlin, 2017. [Online]. Available: https://www.allea.org/wp-content/uploads/2017/05/ALLEA-European-Code-of-Conduct-for-Research-Integrity-2017.pdf

[3] European Commission and High-Level Expert Group on Artificial Intelligence, "Ethics Guidelines for Trustworthy AI," 2019. [Online]. Available: https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=60419

[4] European Commission, "Ethics and data protection," 2021. [Online]. Available: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ethics-and-data-protection_he_en.pdf

[5] Stanford University. "Gendered Innovations ins Science, Health & Medicine, Enginnerung, and Environment." https://genderedinnovations.stanford.edu/ (retrieved Feb. 17, 2023).

[6] Yellow Window Management Consultants, Engender, and Genderatwork, "Toolkit Gender in EU-funded research," Publications Office of the European Union, Luxembourg, 2011. [Online]. doi: 10.2777/62947.

[7] European Health and Digital Executive Agency *et al.*, "Grant Agreement: Project 101091877 - ONE4ALL," 2022.

[8] European Parliament and Council of the European Union, *Regulation on the protecion of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)*, 2016. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679

[9] M. Knudsen and J. Kaivo-oja, "Collaborative Robots: Frontiers of Current Literature," *Journal of Intelligent Systems: Theory and Applications*, vol. 3, no. 2, pp. 13–20, 2020, doi: 10.38016/jista.682479.

[10] F. A. Storm *et al.*, "Physical and mental well-being of cobot workers: A scoping review using the Software-Hardware-Environment-Liveware-Liveware-Organization model," *Hum Ftrs & Erg Mfg Svc*, vol. 32, no. 5, pp. 419–435, 2022, doi: 10.1002/hfm.20952.

[11] European Commission and High-Level Expert Group on Artificial Intelligence, "A definition of Artificial Intelligence: main capabilities and scientific disciplines," 2019. [Online]. Available: https://www.aepd.es/sites/default/files/2019-12/ai-definition.pdf

[12] Stanford University. "Intersectional Approaches." http://genderedinnovations.stanford.edu/methods/intersect.html (retrieved Mar. 6, 2023).

[13] European Commission. "Gender equality in research and innovation: Achieving gender equality in research, how it relates to the European Research Area, networks and news." https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/democracy-and-rights/gender-equality-research-and-innovation_en (retrieved Mar. 6, 2023).

[14] European Commission, "She figures 2021: Gender in Research and Innovation," 2021, doi: 10.2777/06090.

[15] R. von Schomberg, "A Vision of Responsible Research and Innovation," in *Responsible innovation: Managing the responsible emergence of science and innovation in society*, vol. 3, J. R. Bessant, M. Heintz, and R. J. Owen, Eds., Chichester, West Sussex: John Wiley & Sons Inc, 2013, pp. 51–74.

[16] K. Jacob, "Options for strengthening responsible research and innovation: Report of the Expert Group on the State of Art in Europe on Responsible Research and Innovation," 2013, doi: 10.2777/46253.

[17] J. Peckham. “What is responsible innovation, and why should tech giants take it seriously?: Keeping tabs on rapid innovation.” https://www.techradar.com/news/what-is-responsible-innovation-and-why-should-tech-giants-take-it-seriously (retrieved Mar. 6, 2023).
[18] Eurostat. “More women join science and engineering ranks.” https://ec.europa.eu/eurostat/de/web/products-eurostat-news/-/edn-20220211-2 (retrieved Mar. 7, 2023).
[19] Eurostat. “More men with an ICT education employed than women.” https://ec.europa.eu/eurostat/de/web/products-eurostat-news/-/ddm-20221011-1 (retrieved Mar. 7, 2023).
[20] A. Kruse and E. Schmitt, “Digitale Technologie und Gestaltung des Alterns: Notwendigkeit ethischer Diskurse,” *EthikJournal*, vol. 7, no. 2, 2021.