The Ethical Strategy, Challenges and Requirements relevant to the data-driven and AI-empowered CLARUS platform towards the Green Transition in the food industry

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Abstract

In light of the benefits new technologies can offer in terms of data management and elaboration, the digital transformation of food businesses represents an integral enabler of Sustainability Transformation. It is key developing and defining a unique quantitative and standard methodology to support the growth of a green-friendly food industry structure and culture, capable of generating business in a sustainable way and with a much lower negative impact on the environment. The CLARUS project is moving forward in this direction, in view of integrating the Sustainable Paradigm in the food industry and AI-based applications. In this framework, a comprehensive Ethical Strategy was defined, functional to guarantee the legitimacy and fairness of project technologies and validation operations, relying on a human-centric approach. The two pilots chosen for testing and validating the CLARUS solution have been assessed through the ALTAI-driven Ethics and Data Protection Impact Assessment Methodology, in order to ensure the trustworthiness, ethical-soundness and fairness of its AI-empowered assets, as applied in such industrial pilot cases. This exercise was very useful, not only to derive requirements and support the ethics-by-design implementation for the future development work, but also in order to derive high-level recommendations, takeaway and lessons learnt for the expected use of the CLARUS technologies in real-life environments, concretely moving steps ahead for building trust as a prerequisite for harnessing the AI potential in the food industry.

Keywords

Legal and Ethical aspects, Trustowrthy Artificial Intelligence (AI), data, ethics assessment, food industry

1. Introduction

The food sector should find its way toward a Green Transition, by enhancing the environmental and social sustainability of its activities, products, and processes. Considering the benefits that the new technologies can offer in terms of data management and elaboration, the digital transformation of food businesses represents an integral enabler of the desirable Sustainability Transformation [1]. Although the choice to digitize manufacturing processes for food companies is increasingly clear and linear, it does not seem to be the same for achieving better sustainability standards and moving ahead towards an effective Green Transition. In this context, the CLARUS project is strictly associated with the European Green Deal program [2], in order to develop and define a unique quantitative and standard methodology to support the elaboration of a green-friendly food industry structure and culture, that can generate business in a sustainable way and with a much lower negative impact on the environment. It aims to integrate the Sustainable Paradigm in the food industry and AI-based applications.

At the beginning of the project a comprehensive Ethical Strategy was defined, directed to guarantee the legitimacy and fairness of CLARUS technologies and validation operations, relying on a human-centric approach: the safety, empowerment and flourishing of the operator are deemed paramount and thereby put at the center of the technological development and piloting activities,

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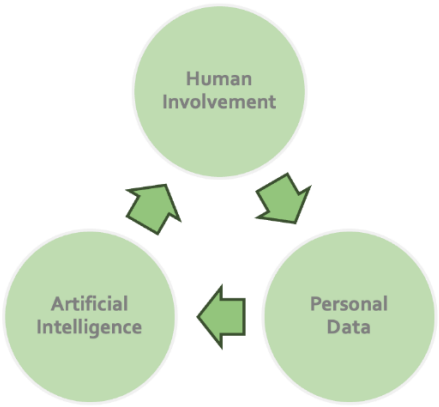
towards giving rise to trustworthy AI-driven technological artefacts, respecting human rights and democratic values.

2. CLARUS Ethical Strategy and the ALTAI-driven Ethics and Data Protection Impact Assessment Methodology

The human-centric approach at the core of the CLARUS Ethical Strategy encompasses first of all the so-called "Fairness Principle", demanding for the safety, empowerment and flourishing of the operator as core driving factors of the technological development and piloting activities. On the other hand, CLARUS human-centric approach is inspired by the Design for Values or value-sensitive design concept, paramount for moving from ethical principles to practical solutions, and follows the Ethics by design paradigm, fostered by the European Commission [1]. Such paradigm calls for the consideration, starting from the beginning of the design process, of the ethical and legal principles to uphold the ethical values and materialize the European human factors in the technology under development (such as dignity, human flourishing, comfort, well-being and empowerment, inclusiveness). This is also aligned with the OECD Principles on Artificial Intelligence [2], which fosters an innovative and trustworthy AI respecting human rights and democratic values, including the materialization of its five complementary value-based principles. Furthermore, the CLARUS Ethical Strategy revolves around the Privacy- and Security-by-Design-and by Default method, encompassing the seven Cavoukian privacy principles [3], to be put at the center of the whole design process, which is aligned with GDPR (art. 25)[3].

As regards the AI solutions, the CLARUS Ethical Strategy deeply refers to the Ethics Guidelines for Trustworthy AI, prepared by the High-Level Expert Group on Artificial Intelligence [4]. These Guidelines, which aren't legally binding, are directed to foster a trustworthy approach, for enabling a responsible and sustainable AI innovation in Europe. They set the ethical principles relevant to build a trustworthy AI, displaying three characteristics: Lawfulness, Robustness and Ethically-soundness.

Thereby, the CLARUS Consortium defined its Ethics and Data Protection Impact Assessment Methodology to ensure the trustworthiness, ethical-soundness and fairness of its AI-empowered assets as applied in its industrial pilots, by referring to such Guidelines and the related "Assessment List for Trustworthy Artificial Intelligence" [5] for self-assessment (ALTAI), elaborated by the same the High-Level Expert Group. Such Methodology was used within the CLARUS Industrial pilots for the assessment of risks for individuals' rights, freedoms and wellbeing, for ensuring compliance with the data protection law (GDPR and national regimes) and ethical mandates in relation to the research with humans, the protection of personal data and the design and/or use of Artificial Intelligence solutions. The Methodology rotates around three building blocks: human involvement, collection and/or processing of personal data and Artificial Intelligence.



[3] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection 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)

Figure 1. Building blocks of CLARUS Ethics and Data Protection Impact Assessment

The first building block concerns the involvement in the operations of individuals, volunteers and stakeholders external to the research staff, for instance during the usability tests, the validation workshops, the testing activities with volunteers, focus groups, questionnaires, interviews, standardized tests and direct observation. In case of such involvement, adequate informed consent procedures and the recruitment procedures have to be defined and implemented. The second building block pertains to the privacy dimension, regulatory compliance and ethical implications of the collection and/or processing of personal data and addresses several aspects, such as the use of specific and "sensitive" tools and techniques, like the use of the video-surveillance, the use of the technologies for access control (authentication, authorization), the use of biometric identification. This component also deepens the ethics procedures and organizational aspects, for instance regarding the appointment of a Data Protection Officer, the possible processing of sensitive personal data and related justification, as well as how the partners are going to adhere to the data minimization principle (anonymization/pseudonymization techniques and other technical/ organizational measures, security safeguards, etc.) and other. The third building block regards the Artificial Intelligence solutions to be used in the pilot context and pertains to the check on the applicability of the Ethics guidelines for trustworthy AI. This assessment was conducted using in a flexible and dynamic manner the ALTAI assessment list. In this way, the CLARUS industrial pilots assessed the respect, in their context and operations, of the ethical principles governing AI, translated into seven requirements that AI technologies should fulfil in order to be considered trustworthy: Human agency and oversight; Technical robustness and safety; Privacy and data governance; Transparency; Diversity, non-discrimination, and fairness; Societal and environmental wellbeing; Accountability.

Considering the objectives of the CLARUS Project, special emphasis was given to the implications regarding the Environmental Well-being, Sustainability and Ecological Responsibility of the AI system: it was under investigation the (potential) positive and negative impacts of the AI system on the environment in order to understand, for instance, i) whether the AI system works in the most environmentally friendly way possible; ii) whether potential negative impacts of the AI system on the environment exist and could be prevented and in which way; iii) if it is possible to establish mechanisms to evaluate the environmental impact of the AI system's development, deployment and/or use (for example, the amount of energy used and carbon emissions) iv) if and which measures have been taken to reduce the environmental impact of the AI system throughout its lifecycle and to ensure the environmental friendliness of the AI system's entire supply chain. This ALTAI-driven deep diving allowed to examine the environmental ethical aspects for highlighting the environmental dimensions of AI, such as its energy footprint and its potential application for environmental protection, encouraging the sustainability and ecological responsibility of AI systems, which is exactly one of the main priorities of CLARUS. Furthermore, it has been already explored which kind of risk-level applies to the AI solution at stake in each industrial pilot, according to the classification of the AI applications described by the AI Act. To elaborate, AI will provide algorithms to optimize the control of the cool installation, but the final decision has to be in the human size. Detection or prediction AIs will not have full control of the process and will only provide alarms that can be ignored by applications. The freezing installation parameter optimization AI will only adjust set points within pre- defined thresholds. Nevertheless, the candidate solutions to implement an AI must be benchmarked considering environment impact. Developers should favor algorithms that have smaller environment footprint (greener AI). Furthermore, the use cases have sensors to monitor and minimize the energy and water consumption.

The described methodology has been proven as very useful to monitor and evaluate human comfort and well-being and, if necessary, take appropriate actions, seeking to inspire confidence in the potential of AI and to build trust. Thanks to this methodology and the whole CLARUS Ethical Strategy, as well as the analysis of the regulatory landscape and the factual analysis of the ethics-and-privacy-relevant properties in each relevant service and tool of the project, the legal and ethical requirements both for CLARUS technologies and for the CLARUS Industrial Pilots were elicited. The next Paragraph provide a snapshot of such requirements for the pilots of the project.
Furthermore, as part of CLARUS Ethical Strategy, a comprehensive legal review was performed. Examining and carefully pondering the overall regulatory and ethical framework relevant to the AI systems and the data-driven tools was considered as essential to ensure the legal compliance of the

CLARUS platform in its design, development, delivery and operation. Several applicable instruments have been investigated in a systematic way or are currently under analysis. A comprehensive analysis of the European regulatory landscape would fall outside the scope of this work. Therefore, the main instruments under analysis are only briefly listed. They include: the AI Act[4] [6] , the first-ever legal framework for AI, the AI Liability Directive (AILD) Proposal[5] [7], the Revised Product Liability Directive (RPLD) Proposal[6] [8], the Regulation (EU) 2023/1230 on machinery and repealing Directive 2006/42/EC and Council Directive 73/361/EEC, the Data Act[7] [9], the Data Governance Act (DGA)[8] [10], the GDPR[9] [11], the Regulation 2018/1807 on a framework for the free flow of non-personal data in the European Union, the e-Privacy Directive [10] [12] and the NIS 2 Directive[11] [13]. The legal and ethical landscape will be further monitored in the upcoming months in order to be fully aware on any regulatory development which could affect CLARUS, towards delivering a value-driven and legal-respectful technology.

3. Legal and ethical requirements for CLARUS Project Industrial Pilots

Two pilots have been chosen for testing and validating the CLARUS solution, notably in view of contributing to resource and logistic optimization methods but even, from a wider perspective, in view of providing a more general solution by creating a Green Deal Index (GDI).

3.1 Food Processing Industrial Pilot

The first pilot (ARDO) specializes in the production of frozen food, where energy and water consumption can be reduced by employing AI and data technologies. The principal activity of the factory concerned is the processing of frozen vegetables. Each stage of vegetable processing differently consumes energy resources and generates vegetable waste. The waste is utilized for animal feed, while the principal external energy resources employed are electricity and natural gas. The main case under investigation in the project focuses on the optimization of energy consumption to sustain cold ambient for the processes of freezing vegetables, maintaining low temperature storage, and cooling water. Water is consumed in the vegetable washing and preparation, blanching and freezing processes. Ardo has a network of water meters installed at the main water receivers. The readings from these meters will be collected for analysis. In the project the main objective is the optimization of consumption in the production of vegetables. A network of meters associated with the different production equipment is going to be installed, mainly those that have a greater impact on water consumption to access data associated with the accumulated consumption values and flow rates at a given instant to be stored in a database for processing and analysis.

As part of the legal and ethical strategy implementation, first of all a legal review have been conducted, focusing on the legal and ethical framework related to the technology involved in the pilot, for identifying the relevant regulatory sources, such as legislations, standards, sector-specific policies, company practices/policies and other non-binding sources, in addition to the relevant European-level regulatory framework. They include, among others, Ardo Benimodo Code of

[4] COM(2021) 206 final, Proposal for a Regulation of the European Parliament and of the Council laying down harmonized rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union legislative acts

[5] COM (2022) 496 final "Proposal for a Directive of the European Parliament and of the Council on adapting non- contractual civil liability rules to artificial intelligence"

[6] COM (2022) 495 final, "Proposal for a Directive of the European Parliament and of the Council on liability for defective product"

[7] Regulation (EU) 2023/2854 of the European Parliament and of the Council of 13 December 2023 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828

[8] Regulation (EU) 2022/868 of the European Parliament and of the Council of 30 May 2022 on European data governance and amending Regulation (EU) 2018/1724

[9] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection 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

[10] Directive 2002/58/EC on privacy and electronic communications, replacing the Directive 97/66/EC and partially amended by Directive 2009/136/EC

[11] Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union, amending Regulation (EU) No 910/2014 and Directive (EU) 2018/1972, and repealing Directive (EU) 2016/1148

Conduct and Ardo Group Ethical Policy, The Spanish Basic Code Ethical Trading Initiative (ETI)[12] [14] , the Spanish Criminal Code and the Law 2/2023 (20 February), regulating the protection of persons who report regulatory breaches and the fight against corruption. In case of human involvement and personal data collection and/or processing, all the ethics protocols and procedures will be followed. As regards the AI tools, the ALTAI requirements have been analysed and pilot specific requirements elicited. The system is considered a limited risk system, pursuant to the AI Act risk-level classification. As regards the environmental well-being, sustainability and ecological Responsibility of the AI system, a key role is going to be played by the sensors installed throughout the cooling and water installation to monitor and minimize consumption and by the analysis of the collected data. Human agency and oversight are ensured by the circumstance that humans have to take the control of the cool installation regarding the implementation of optimization AI and the optimization of the control variables of the cool installation: notably, though AI will provide algorithms to optimize the control of the cool installation, nevertheless the final decision will be in the human control. Detection or prediction through AI will not have full control of the process and will only provide alarms that can be ignored by the applications. Furthermore, the freezing installation parameter optimization AI will only adjust set points within pre-defined thresholds. To meet the ALTAI requirement related to privacy and data governance in relation to the implementation of AI algorithms in the optimization of the cool installation, the data will be stored and processed in local servers. Training datasets will only be available to third-party via specific agreements and ad-hoc connections. Furthermore, as regards the same implementation of AI algorithms in the optimization of the cool installation, it is key that the system operators know what AI does and how to revert the system: they will be trained on what the different AI algorithms do. The system also must show when the algorithms are active and have the possibility to deactivate them and return to the initial situation. The main objective of the AI models is to empower humans, let them focus on higher added-value tasks, and this needs to be supported by adequate training and upskilling programs. It is also critical that, before implementing the AI algorithms, a risk assessment is performed in order to consider the possible implications that it could have on the installation from the security level. This is mainly due to the ALTAI "Technical Robustness and Safety" requirement. The machine room setpoints will be modified by AI algorithms directly or through recommendations. The results of the algorithms must be tested regularly, ensuring that they fulfill the functions for which they were designed and that no variables appear over time that could cause anomalous operation. It is necessary the tracking of algorithms in the implementation in Ardo use cases. This is also related to the accountability requirement. In this regard, in particular concerning auditability and accountability of results, the Consortium is currently exploring mechanisms that facilitate the auditability of the AI system, providing traceability of the training process. The system must provide means to ensure that third parties can audit the AI system, for instance. The Ethics Advisory Board of CLARUS will audit the process to oversee ethical concerns and report potential risks or biases.

3.2 Bio-production Industrial Pilot

The other pilot (HONKAJOKI) focuses on the meat by-product production, where CLARUS aims to reduce the energy and help to maintain the quality of the products by optimizing the logistics of the by-product's arrival. The factory concerned is a leading processor of animal by-products. The pilot focuses on major side streams, which are deriving from broiler slaughterhouses in Finland. The by-products are collected from three sides: large slaughterhouses, small and private businesses, and cadavers from primary animal production. Following the EU regulation (EU 1069/2009), the incoming by-products are categorized into three categories: i) high-risk material ii) medium-risk material iii) non-edible by- products from ante and post-mortem inspected animals which have been approved for food use. The material from this category forms the basis for the most valuable end-products: these by-products are refined on animal-specific processing lines. By employing the vast historical data streams stored in the factory's Data cloud system, the CLARUS project is going to develop models facilitating the prediction of the optimized process conditions, thus supporting the achievement of optimal outcome in terms of resource use (energy, water) and end-product quality. This way the raw

[12] El Código Básico Iniciativa de Comercio Ético Ethical Trading Initiative (ETI)

material can be used to its best potential according to the European Waste hierarchy using minimal possible efforts. However, possible cause-and-effect relationships and intricate operational decisions are still sometimes left for human decisions. As part of the legal and ethical strategy implementation, also in this case first of all a legal review was conducted, similarly to what described for the ARDO pilot. The relevant sources include, among others, Honkajoki Group Code of conduct, the Decree 783/2015 of the Ministry of Agriculture and Forestry on animal by-products, regulating the usage of side streams derived from animals and comprising provisions for the safe handing, processing, and transporting animal by-products, and the Regulation 1069/2009/EC of the European Parliament and of the Council and its supplementary Commission Regulation 142/2011/EU, concerning the collection of by-products and the use of final products derived from them.

In case of participation of human beings and personal data collection and/or processing, all the ethics protocols and procedures will be followed. Also in this case, ALTAI requirements have been analysed and pilot specific requirements elicited. The system is considered a limited risk system, according to the AI Act risk-level classification.

The environmental well-being, sustainability and ecological responsibility of the AI system in this pilot is related to the sensors to monitor and minimize the energy and steam consumption. Human agency and Oversight are essential also in this case and the users have to be in the control of the process in relation to the implementation of optimization AI for logistics and meat rendering process: AI will provide outputs to optimize the logistics and the meat rendering process, but the final decision must come from the product line operator or truck driver. Furthermore, users must know what AI does and how to intervene with the system: the production line operators and drivers have to be trained on what the different AI algorithms do and the users have to be aware when dealing with AI outputs and have the possibility to intervene with the system and use their preferred method. As regards the implementation of AI algorithms in logistics and production line optimization, attention is given to the ALTAI-driven Privacy and Data Governance requirement: the data is stored into AWS cloud. Datasets are available to 3rd party via encrypted and limited API access. Technical Robustness and Safety is paramount: before implementing the AI algorithms, a risk assessment must be performed. AI algorithms recommendations and warnings are not to be accepted as absolute truth and must always go through trained personnel. For the implementation of AI algorithms in logistics and production line optimization, on the one hand, the results of the algorithms must be tested regularly, ensuring that they fulfill the functions for which they were designed and that no major deviations from the data sources or unforeseen variables appear over time that could cause anomalous operation. On the other hand, the ALTAI "Diversity, Non-discrimination and Fairness" Requirement must be complied with, ensuring that the used data only contains production line and logistics information, so that no bias can be included that can discriminate anyone. The Design and tracking of algorithms in the implementation in Honka use cases must ensure the auditability of the results and accountability: the data flow in edge and cloud services should be traceable, and approaches should be integrated to support auditability of the dataflow and the AI solution making use of the data. This approach should be in line with the general ethical approach maintained in the CLARUS project.

4. Conclusions

In this document the ALTAI-driven ethics-related methodology for the ethics assessment have been described, together with the efforts made by the Consortium in adhering to the Ethics-by-Design- and -by-Default approach and human-centric method, analysing and taking into account the ethical implications raised by its Food Processing Industrial Pilot and Bio-production Industrial Pilot. This demonstrates awareness and commitment in aligning the design, development, deployment and testing of the CLARUS technological assets in compliance with the applicable regulatory framework and ethical mandates, as well as with the Ethics Guidelines for Trustworthy AI. Such a commitment is functional to give rise at the maximum possible extent to human-centric and ethically-sound technological breakthroughs and to take, when necessary, the proper safeguards and mitigating measures in order to avoid any negative impact on fundamental rights and European values of the

operators and of any individual at stake. Most of the use cases are not going to involve external humans in their operation: only the research staff is expected to take part to them. In case of external participants, still they will be staff coming from SMEs or other organizations within the partners' professional network, such as resources of IT providers and/or of production providers that work with the partner hosting the piloting activities. Great attention is also given to GDPR compliance: most of use cases do not collect and/or process this kind of data and, when relevant, anonymization techniques are applied and all the requirements stemming from the data protection legislation are met. Likewise, as regards the AI systems developed and/or used by the experiments, all the ethical requirements set by the Ethics Guidelines for Trustworthy AI and related Assessment List ALTAI are going to be met by CLARUS Industrial pilots and an in-depth analysis of the ALTAI requirement has been conducted, resulting in guidelines for the technical partners for the future development of CLARUS technologies, by prioritizing human well-being and flourishing and by deepening the legal and ethical implications of each human-machine testing activity. This exercise was very useful, not only to derive requirements and supporting the ethics-by-design implementation for the future development work, but also in order to produce recommendations, blueprints and lessons learnt for the post-project phase. In such phase the technological artefacts of this research are expected to be used in real-life environments: it is therefore key to address pressing concerns surrounding AI technology and its fast-changing developments in the food industry and tackling with them, seeking to inspire confidence in the potential of AI, concretely moving steps for building trust as a prerequisite in harnessing AI potential also in this domain. Trust is of upmost importance in order that workers are favourable in supporting this change as well as consumers are willing to engage with products that embed AI technologies.

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Declaration on Generative AI
The author(s) have not employed any Generative AI tools.

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