Report on Exploitation and Sustainability Strategy M12

D2.1

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Abbreviations and Acronyms:	
CA	Consortium Agreement
DS	Data Space
EC	European Commission
EPI	Environmental Performance Index
GDI	Green Deal Index
GDPA	Green Deal Performance Assessment
GDPR	General Data Protection Regulation
IDSA	International Data Space Association
IPR	Intellectual Property Rights
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
ML	Machine Learning
OS	Open Science
PESTLE	Political, Economic, Social, Technological, Environmental, Legal
SAAS	Software As A Service
SDG	Sustainable Development Goal
SME	Small and Medium sized Enterprise
SWOT	Strengths, Weaknesses, Opportunities, Threats
TEO	Tangible Expected Outcome
UI	User Interface
UX	User Experience
WP	Work Package

1. Executive summary

Within the present report, we provide an intermediate status of CLARUS exploitation and sustainability strategy. Our primary focus is to create the foundations for a valuable and viable business model for the three CLARUS TEOs that are sustainable beyond the project end. By applying a broad mix of methods and tools we gained insights into relevant stakeholders, existing competition, the business environment, a first strategic orientation, and derived recommendations for future project work.

The report gives an overview of the actual status of the three CLARUS TEOs and an update on our general exploitation strategy (individual and joint exploitation) including the intellectual property rights (IPR) management. From our conducted (market) environment analysis (PESTLE) we got rich information on each of the six analysed categories. All identified factors were briefly described, classified as positive or negative and summarised in a table. The results were further processed in the finally conducted SWOT analysis.

In order to get a broad overview of the competitive environment 27 GDIs, Data Spaces and AI-Toolkits were identified and evaluated through web-based research. The analysis covers an overview of offered features and functions, organisational insights, strengths & weaknesses as well as impressions on usability and user experience. In general, the analysis shows that there are separate market potentials for all three domains of CLARUS TEOs. A unique selling proposition can be created by combining two or all three TEOs, as this has not yet been available on the market.

Finally, the conducted SWOT analysis shows first insights on how we can use our strengths to balance our threats and weaknesses, how to minimise risks, and what is needed to take the most significant possible advantage of chances for success.

2. Introduction

Within the CLARUS project, we follow the approach promoted by the European Commission (EC) that publicly funded research should lead to the exploitation of results, which goes one step further than the mere production and dissemination of new scientific knowledge[1]. With our project activities, we want to overcome the "European paradox" and show that a translation of scientific advances into marketable innovations is possible. Our understanding of innovation is not only the promotion of dissemination but especially the subsequent exploitation of the project results. Besides the research exploitation (re-utilisation of the research know-how) and the technological exploitation (re-utilisation of the technological know-how), we put our primary focus on the exploitation of the three planned Tangible Expected Outcomes (TEO), the CLARUS Green Deal Index, the CLARUS Data Space and the CLARUS AI-Toolkit.

The present report is the first outcome from WP 2 (Business Ecosystem and CLARUS Dissemination and Exploitation), which aims to create a valuable and viable business model for the CLARUS TEOs that are sustainable beyond the project end. Our approach to this is based on design thinking procedures and business model innovation methods. In general, it is about planning and developing in a user-oriented way. People, processes, products and technologies interact with each other and have to be coordinated and linked in a holistic way.

2.1. Exploitation and Sustainability

Within the project, particularly within WP2, we are primarily guided by Alan Cooper's interaction design principles[2] for developing a successful digital product. The main guiding principle is:

A successful digital product (service) needs to be desirable, viable and buildable.

In our exploitation considerations, we are also applying this principle to business models. The business model scenarios for the three CLARUS TEOs need to be feasible, desirable and viable in order to be sustainable after the project ends. The intersection of these three processes (desirability, viability, and feasibility) defines the sweet spot of innovation where we aim to be. Getting there requires a multi-framework approach which is realised in the CLARUS project by a clearly defined WP/Task structure and respective responsibilities.

[1] European Commission (2013): How to convert Research into Commercial Success Story https://era.gv.at/object/document/751

[2] Cooper, Alan, Reimann, Robert, & Cronin, David (2007). About face 3: the essentials of interaction design. New York: John Wiley & Sons

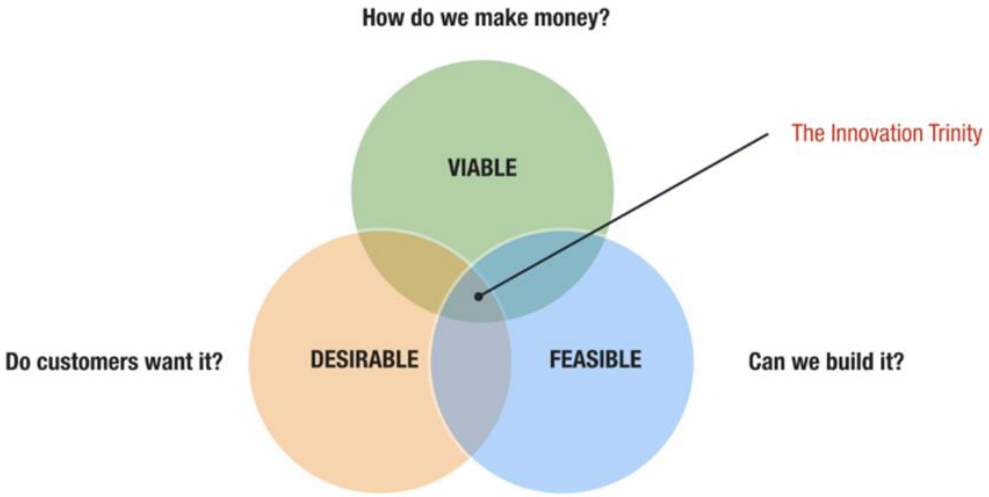

Figure 1: The Innovation Trinity

2.2. Objectives and Structure of the Report

The present report outlines the first version of the Exploitation and Sustainability Strategy for the CLARUS project. The results are, on the one hand, a joint work of the WP2 team with the support from the whole consortium and, on the other hand, a further development of the exploitation part outlined in the project proposal. The main objectives of the Report on Exploitation and Sustainability Strategy report are:

- provide an overview of the actual status of the three CLARUS TEOs and an update on the general CLARUS exploitation strategy
- obtain knowledge on CLARUS business environment
- receive detailed information on competition in terms of offerings, organisational insights, strengths & weaknesses as well as learnings and recommendations for CLARUS offerings
- gain input for CLARUS competitive position and strategic planning

For achieving the above-mentioned goals, a broad mix of methods and tools has been used. The report starts in section 2 with an update on the CLARUS general exploitation strategy (individual and joint exploitation) including the intellectual property rights (IPR) management. In section 3 the PESTLE analysis was used to screen the business environment. This should help to examine positive or negative external events and influences for the CLARUS TEOs. In order to get a profound picture of existing solutions compared to CLARUS expected developments, the WP2 team conducted an in-depth competitor analysis which is presented in section 4. In section 5 we used a SWOT analysis to evaluate CLARUS competitive position and derived the first input for future strategic planning. Finally, the report concludes with a summary section.

2.3. Actual Status of the CLARUS TEOs

The current development status of the three CLARUS TEOs is based on the outcome of the respective requirement tasks 1.2 for the Green Deal Index, 3.1 for the CLARUS Data Space and 4.1 for the CLARUS AI-Toolkit. For developing a successful path towards exploitation, we need a profound understanding what the actual results are (will be) and what needs to be until the end of a project (and beyond).

2.3.1. CLARUS Green Deal Index

According to the Green Deal initiative, the European Commission (EU) has committed to achieving zero emissions by the year 2050. This ambitious goal necessitates significant advancements in various areas, such as technology, research, regulation, and more, to successfully implement the intended plan. The CLARUS proposal is closely aligned with the European Green Deal initiative. Its primary objective is to create a unique and standardised quantitative methodology that supports the development of an environmentally friendly food industry structure and culture. This approach aims to enable businesses to operate sustainably, reducing their impact on the environment.

One of the outputs of the CLARUS project is the development of the Green Deal Performance Assessment (GDPA) methodology that consists in a quantitative environmental sustainability methodology (with related KPIs) for the environmental sustainability assessment of food manufacturing systems.

The GDPA has been presented together with the first consideration about its interrelation with the other CLARUS TEOs (AI Toolkit and Data Space) in deliverable 1.2. The content of D1.2 should be used as a reference point for the sustainability metrics to be used for evaluating CLARUS solution from an environmental sustainability performance point of view. The overall scheme of the proposed GDPA methodology is reported in Figure 2.

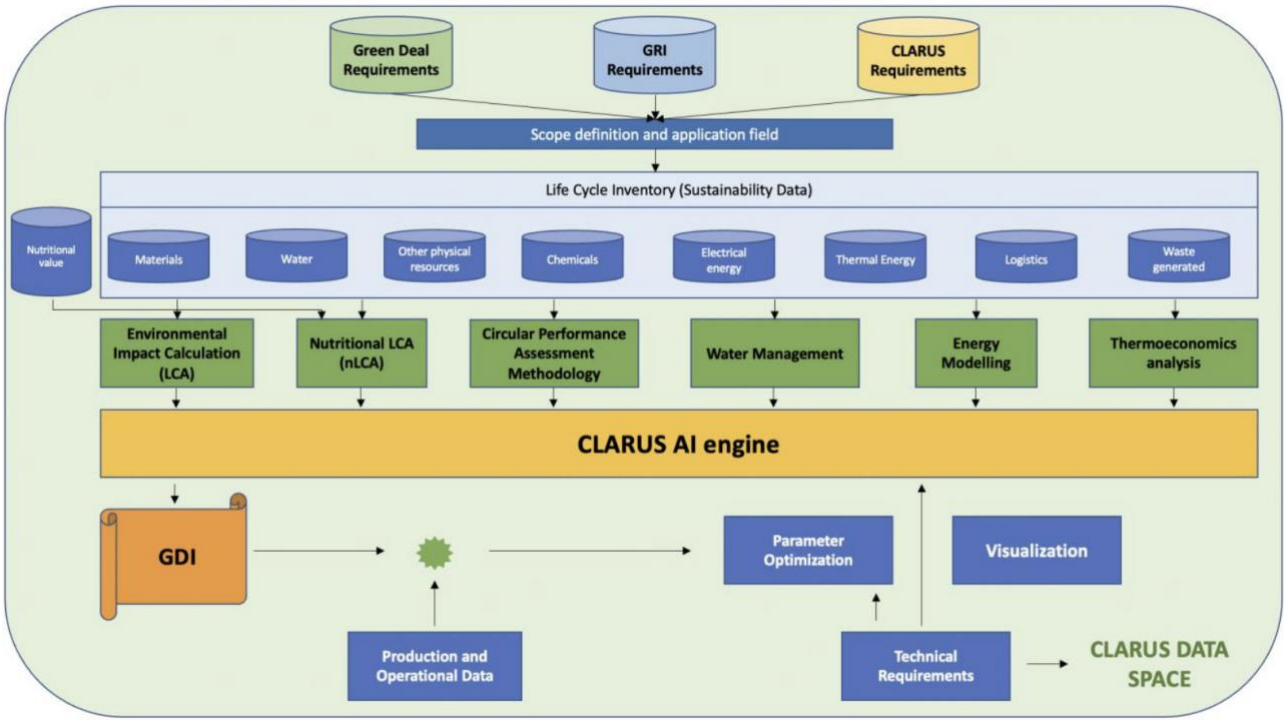

Figure 2: GDPA methodology scheme

Then CLARUS O1.1 "Development of data-driven methodology models/metrics for environmental sustainability assessment, efficiency, and manufacturing digital adoption (i.e., Green Deal Performance Assessment methodology)" can be considered achieved while still, some minor changes adjustment may come in the next months of the project especially when dealing with the definition of a quantitative metrics able to deliver a final index: the Green Deal Index (GDI).

2.3.2. CLARUS Data Space

The CLARUS Data Space will enable Project Use Cases execution providing a trusted environment where different actors may access each other's data under the principle of data sovereignty. The CLARUS Data Space design and development is the main result of WP3, CLARUS Data services and from a technical perspective, the initial activities towards the definition of the Data Space have been reported at M9 in D3.1 CLARUS Data Approach.

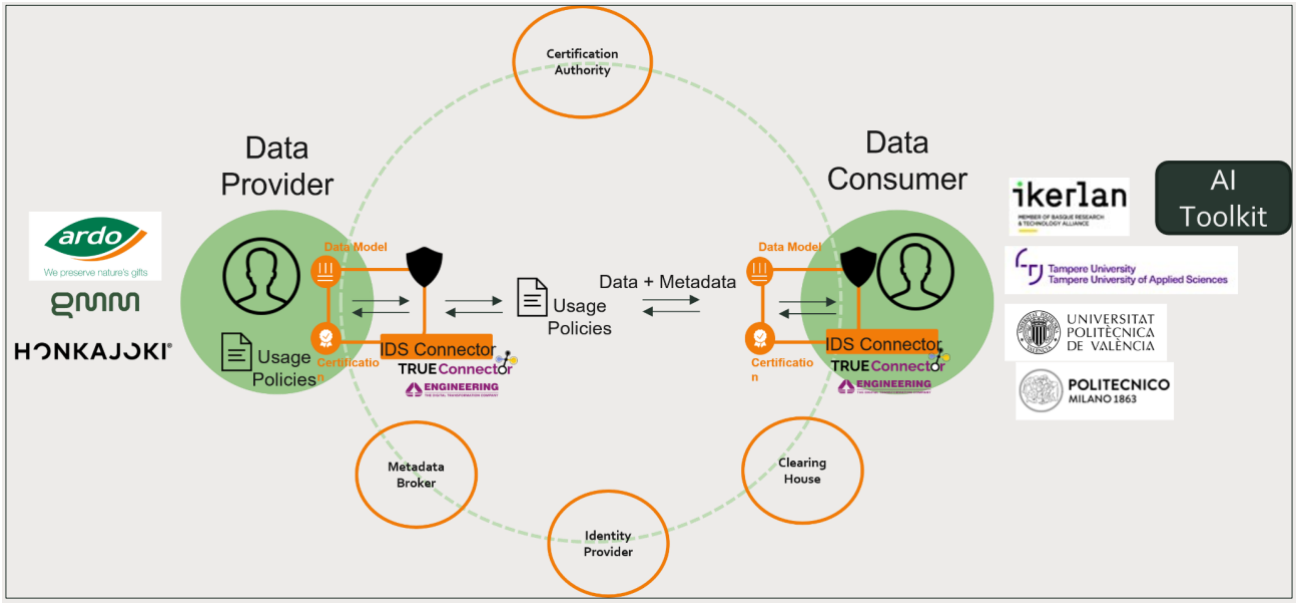

Figure 3: CLARUS Data Space high-level scenario description

The CLARUS Data Space will be based on the IDS (International Data Space) architecture and specifications which can be considered the European standard at present. IDS offers a flexible framework that can be enriched with other blocks or sub-blocks for better integration with an existing technology stack or to amalgamate and consolidate different technologies, and parts of heterogeneous systems. This flexibility allows the technical scaffolding of a solution to be built, also making it open to future modifications.

The CLARUS Data Space will enable the co-creation of a standards-based solution, where project partners will play the role of the data provider and data consumer: pilots may share their data with technical partners, who may offer their specialised services through the Data Space by connecting the metadata of their Apps (e.g., AI Services, Data Harmonization services etc.). The analysis/harmonisation results will be then accessible by pilots, also through automated Decision Support Systems and notification features. The full definition of the Data Space and the scenarios associated is still ongoing and will be better refined in the upcoming months.

2.3.3. CLARUS AI-Toolkit

The CLARUS AI Toolkit includes the AI algorithms that are developed to solve the problems raised in the use cases, as well as the management of the life cycle of said algorithms, which includes tasks such as data collection, processing, training, validation, inference, and monitoring. The work carried out so far has consisted of identifying the most appropriate MLOps tools in the context of the project and designing and developing the different components and services that are going to be in charge of automating the life cycle

and that allows for complete traceability of what happens at every step of the process. The design of the software being worked on is depicted in Figure 4.

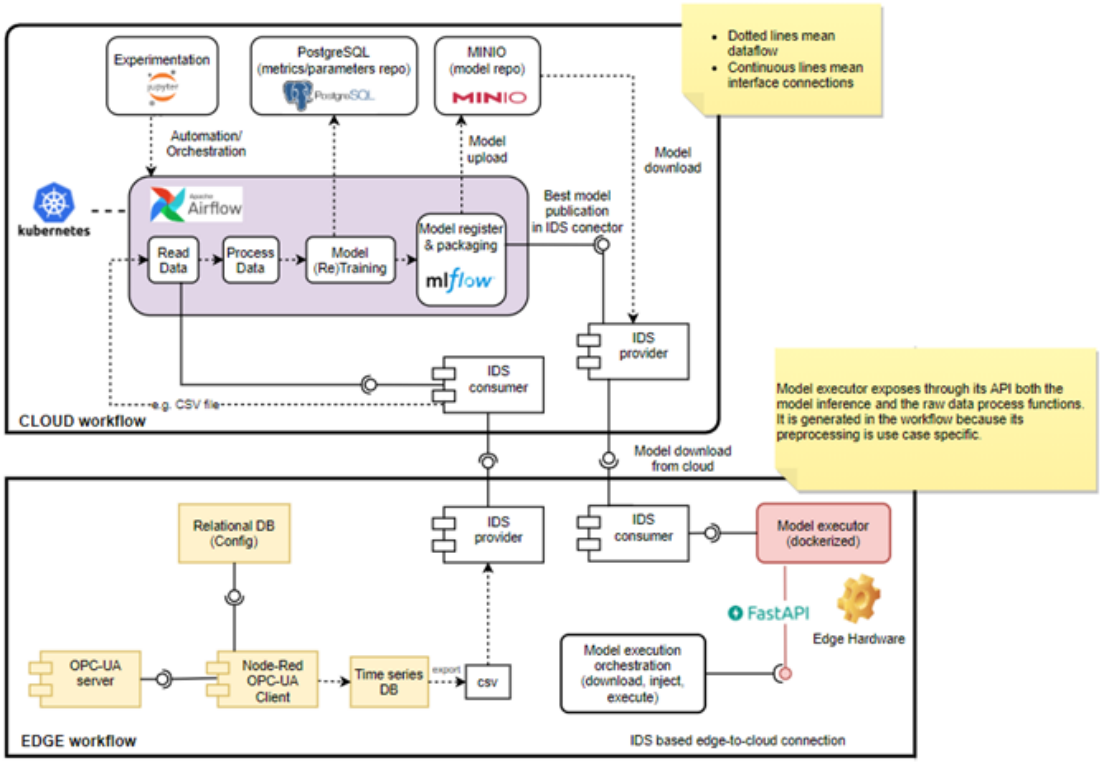

Figure 4: Software Design for AI Toolkit

The Edge layer would include the data collection part and the inference part, mainly. Regarding data collection, UPV has developed a workflow using the Node-Red tool where data collection and registration in a database is automated. Data collection is carried out by an OPC-UA server that allows interoperable and secure communication between different devices. This collected data set would be registered and consumed using the TrueConnector provider and consumer (located in the Cloud), respectively, implemented in task 3.2. (Edge Data Management Services). At the moment, this data collection using the OPC-UA server is not integrated with the full workflow of MLOps, instead, we are using an open-source dataset that is registered in the Edge connector to be later consumed in the Cloud. Regarding the inference, the logic to be followed is very similar, but in this case, the model is registered in the Cloud and consumed at the Edge, where an endpoint is provided (through the Fast API service) to calculate the predictions from a data set of interest. This part is currently under development.

In the Cloud layer, we would have the main workflow that manages the entire life cycle of the models. We have integrated a set of dockerised services that meet different needs. The experimentation phase is carried out in a Jupyter notebook, where the code is tested before deploying into production. The lifecycle of such code is automated through the Airflow tool, which automatically performs the following main tasks: reading data, processing, training and validation, and final packaging. For the moment, the functions involved in these tasks use the public data mentioned above, with the final objective being the incorporation of the specific code developed in the different use cases. To achieve a complete generalisation and extrapolation of this service to other contexts, we are working on the creation of several templates, one for each task involved in the workflow, that specifies the type of input and output that each task must receive and return, so that content may be modified as long as these specifications are maintained. A very important part of

model lifecycle management is traceability, i.e., the ability to have all the desired information related to model training (data used, metrics obtained, time of execution, etc.). To ensure this traceability we have included the MLFlow service, which provides a simple way to track the executions carried out. This service has been integrated with two storage services that allow, on the one hand, the storage of data in tabular structures, such as PostgreSQL, and, on the other hand, the storage of objects, such as Minio. The first stores the information related to the training (parameters, metrics obtained during training and validation, etc.) and the second stores the model itself with all its dependencies.

The next steps in the development of the CLARUS AI Toolkit are aimed at exposing the trained AI model through IDS (TrueConnector) and polishing the different components in a way that they are as generic and robust as possible for future use case integration. With regard to the development of the AI models to be integrated into this architecture, both TAU and UPV are working on (1) identifying the types of algorithms that are most suitable for the different pilot projects, (2) collecting and analysing the available data sources, and (3) mapping the results of the AI algorithms with the Green Deal Index in order to be able to calculate the KPIs that evaluate the benefits of the AI techniques.

3. Plan for Exploitation of Results

Exploitation is recognized as the key enabler for the success of the CLARUS project. Hence all partners within the project are aware of and committed to the exploitation of the project results, and the proposed project research and development focus strongly adheres to their research and business strategies. The Consortium Partners with their diverse and complementary Research and Business contexts and capabilities provide all potential exploitation modalities and routes to bring CLARUS results to all targeted user groups.

Exploitation Models: The CLARUS consortium recognises three main exploitation models for the project results: 1) The **commercial exploitation model**, which implies the paid provision of the project results to the end users, complying with a pricing scheme which will be defined in the CLARUS business plan, 2) The **research exploitation model**, which implies the re-utilisation of the research know-how acquired in future research activities, and 3) The **technological exploitation model**, which implies the re-utilisation of the technological know-how acquired for the development of innovative products and the provision of advanced services built on top of them. However, not all project partners and interested stakeholders may exploit all project results using the three models defined above. The exploitation models of the CLARUS project results will be dependent upon three main parameters: a) the nature and interests of the project partners and stakeholders in general, b) the distribution model (commercial or non-commercial) of the project results and c) the distribution of the IPRs amongst the project partners.

3.1. Exploitation Management

In general terms, the exploitation strategy depends on the actual exploitable assets. The exploitation strategy of CLARUS project follows a stepwise approach and is based on the combination of a bouquet of activities which span throughout the project duration. It varies in intensity based on the amount of information that can be made available and the results that are achieved during the project's lifetime. In addition, different exploitable assets may be exploited by different stakeholders based on the management of intellectual property rights (IPR).

The project exploitation strategy comprises a bouquet of exploitation activities which include:

1) the identification of the innovative exploitable assets, whether these are technological components (CLARUS Data Space or CLARUS AI Toolkit) or added value services (CLARUS Green Deal Index), which the project will deliver through its results to its target customer groups
2) the conduction of a thorough market analysis which will aim at the identification of the market towards which CLARUS is targeted, its segmentation, the positioning of current competitors and all corresponding emerging trends
3) the analytical definition of all possible commercial and non-commercial exploitation models, which have been preliminarily identified and are outlined in the following paragraphs
4) the analytical definition and evaluation of the sustainability and viability of possible business models and alternative solutions that may be followed for the provision of the project solution and services to the identified stakeholders, including licensing schemes, pricing, etc., and the corresponding tactical revisions as deemed necessary throughout the project lifecycle
5) the establishment of relationships of trust with customers/users early within the project, who can facilitate the quicker adoption of the solution and provide valuable feedback which can be used in the commercialization phase
6) the identification of financial support from diversified funds (including for example institutional funds or other private and/or public funds) that can be used to support direct and/or indirect

commercial transformation, ranging from additional research activities to bug fixing and technology integration in existing or future solutions

Exploitation Intensity: The exploitation activities will vary in intensity based on the delivery of the project results and the acquisition of R&D know-how. Towards this end, the exploitation activities have already started mildly with the identification of the innovative exploitable assets of the project and the conduction of a preliminary market analysis identifying potential stakeholders and competitors. The activities will be intensified prior to the delivery of the intermediate project results with a more analytical definition of all possible commercial and non-commercial exploitation models and definition and evaluation of the sustainability and viability of possible business models and alternative solutions. The exploitation engagement will peak prior to the delivery of the project final results, when the project dissemination activities will also be intense, attracting potential stakeholders and customers. Following the project's end, the CLARUS consortium will aim at creating appropriate business networks and at exploiting the project results.

Exploitation Objectives: The exploitation strategy of CLARUS will follow three main stages of expansion with specific short-term, medium-term and long-term objectives: 1) Short-term objectives: This first stage corresponds to a period beginning with the start of the project activities and ends in parallel with the project. During this period, the main objective is to develop the CLARUS solutions (AI Toolkit, Data Space) focussing on high usefulness and usability. Furthermore, we verify and validate the CLARUS results, concepts, models, tools and services. 2) Medium-term objectives: This second stage corresponds to a period beginning with the end of the project and ending after two or three years, depending on the maturity and completion of the project results. The main objective includes the commercialization of the "to date" results and developments of almost market-ready products and services, while it further relates to potential finetuning or expansion of the CLARUS solutions. 3) Long-term objectives: Corresponds to the commercialization of the CLARUS solutions derived from the first and second stages (short-term and medium-term).

3.2. Individual Exploitation Strategies

The main purpose of the individual exploitation plan is to ensure, for each partner, the effective use of project results. The foundation for individual exploitation is the diverse and complementary research and business contexts and capabilities of the consortium partners and their willingness to make CLARUS project results available to all targeted user groups. To concretise and update these ambitions we administered a survey with the following questions to all CLARUS partners:

- How would you prioritise your exploitation ambitions (e.g., scientific, business, technical progress, knowledge gain, visibility, image/reputation etc.)? Please rank and start with the most important one.
- What concrete (if possible measurable) results do you expect for your organisation? What gains/benefits do you expect?

The results of the first question are presented in Figure 5. Universities placed their main focus on scientific exploitation. The company partners (small, medium and large enterprises) plan to exploit the CLARUS results to support their businesses. The research institutes have a more balanced ratio between business and scientific exploitation ambitions.

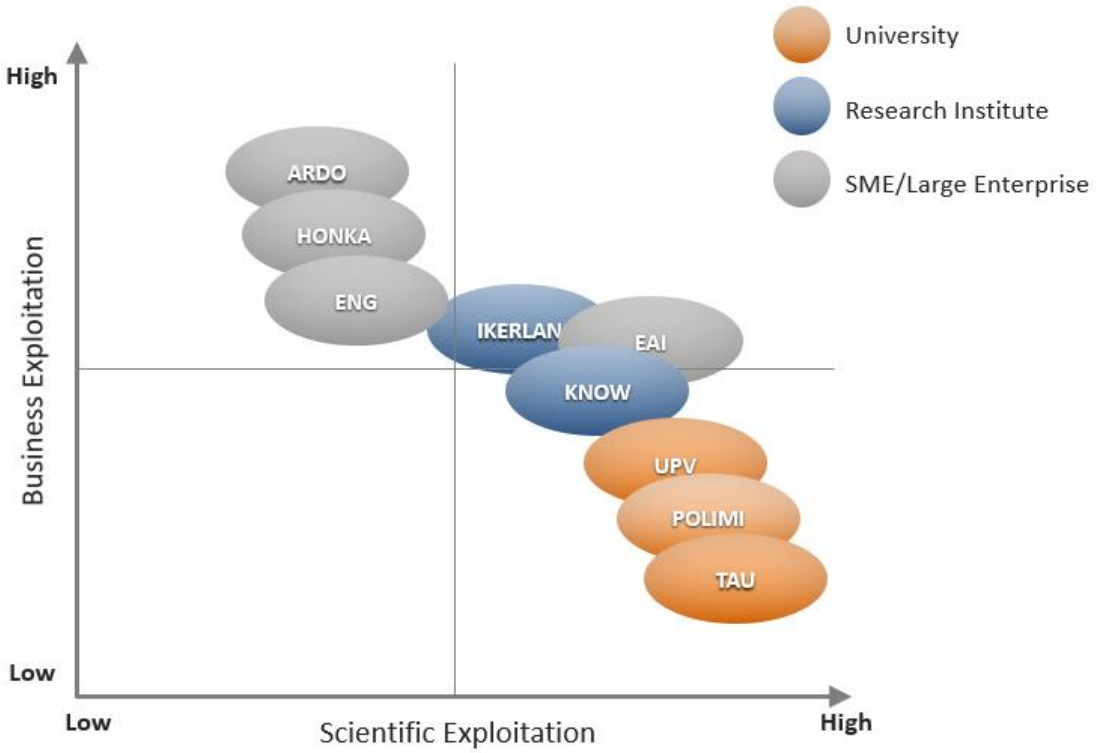

Figure 5: Individual exploitation ambitions of project partners

CLARUS partners are well balanced with Universities (3), Research Institutions (2) and enterprises of different sizes (4). This means that the exploitation interests of the consortium members represent a mix of revenue and knowledge generation (as shown in Figure 5). In addition to this complementarity of business models, different exploitation strategies (for example, in terms of volume of use and degree of adaptation of the project outputs in the exploitation phase) of the beneficiaries further increase the potential impact of the project.

Table 1 shows in detail the current status/plan of the individual exploitation ambitions of each consortium partner. This wide range of expected benefits and results forms a solid basis for the effective exploitation of CLARUS's project results.

Partner	Partner Type	Concrete expected benefits/results
POLIMI	University	POLIMI's individual exploitation plan is mostly connected with the consultancy services related to the GDI. POLIMI will exploit the resulting benefits of the Green Deal Performance Assessment methodology and of the Green Deal Index (GDI) that will be developed to improve its researcher's knowledge and skills, consultancy services, develop new possible educational and training courses in the topics of the CLARUS project, enhance the knowledge and influence of Italian and European University Community. POLIMI will try to exploit the knowledge from AI algorithms development in other research contexts in the food industry and broader manufacturing contexts.

TAU	University	TAU exploitation involves supplying the know-how through consulting/training, improving the regular courses at the University on Digital twins and Industrial Communication/Data Modelling Protocols such as OPC-UA developed at CLARUS. This knowledge will be used in future research projects. for TEO1, TAU will utilise the outcome in developing digital threads that are aligned with the Green Deal Concept.
UPV	University	UPV intends to spread the project results among Spanish companies. CIGIP has a lot of experience in enterprise consultancies in different sectors (automotive, ceramics, metal-mechanic, capital goods, textile, furniture, agro-food, etc) with over 100 contracts and 2 million Euro incomes from technology transfer to companies representing a solid base and credibility for past exploitation
ENG	Large Enterprise	ENG's R&D department will transfer technologies and knowledge acquired from its involvement in the project to ENG's own Industry & Services business unit which will exploit technological partnerships with the market's main players, in both SW application solutions and technological platforms.
IKERLAN	Research Institution	IKERLAN is a leading knowledge transfer technological centre providing competitive value to companies. Due to the proximity to companies, IKERLAN will use the acquired knowledge and outcomes of CLARUS to help industrial companies with their big data analytics platforms, data acquisition systems, IoT connectivity, protocols and communications, simulations, predictive analytics, visualisations and all the systems and tools developed during the project.
KNOW	Research Institution	KNOW aspires to i) re-use the knowledge and competencies acquired, gathered and developed within the project in future research projects/activities, ii) acquire new scientific and/or industry partners to support the Green Deal with AI, iii) to enlarge the consultancy innovation services to support AI-driven business model development and iv) to secure the R&D position of KNOW on a national and international level as Research Center for Data-Driven Business and AI.
EAI	SME	Through CLARUS and the acquired know-how EAI will improve its offering, making it more attractive, and will reuse the project's methodologies and outcomes, such as the Ethics and Data Protection Impact Assessment tool, to investigate and implement further models, solutions, services and methodologies in Responsible and Trustworthy AI relying on the Green Deal Performance Assessment methodology and the Green Deal Index, in line with the findings of key initiatives like the IEEE Global A/IS Ethics. EAI will also exploit the knowledge and competencies gathered and/or generated within CLARUS in future research projects/activities, boosting the design, development and operation of AI-empowered services for the benefit of the whole society, whilst fostering EU competitiveness.
HONKA	Industry	The AI solution will help to optimise the logistics of the food by-products in terms of environmental footprint. The whole production chain will be optimised for minimal use of resources (energy, water) and best possible end-product nutritional quality and economical value
ARDO	Industry	CLARUS offers a wide range of possibilities to be implemented into ARDO's future business model: the main goal is that CLARUS AI Services help ARDO to achieve water consumption reduction, energy savings, plastic savings, and waste generation reduction in its food production and optimise its manufacturing and logistics processes.

Table 1: Individual Exploitation Survey Results

Summary of the individual Exploitation Survey Results:

The top 3 priorities for exploitation ambitions are Business, Knowledge Gain and Technological Progress. Less interested are the partners in Scientific Exploitation as well as gains in Visibility and Image or Reputation.

The expected benefit/results derived from exploitation activities vary from partner to partner, for example:

- consultancy services related to GDI and support AI-driven business model development
- develop new possible educational and training courses
- improving the regular courses at the University
- transferring the gained knowledge and technologies to businesses (industry and services)
- use the CLARUS developments for optimising the internal (own) business model (logistics optimisation, reduction of energy, water and waste)
- re-use the gathered knowledge and competencies for future research projects and activities

From these analysis results, we can draw the following recommendations for CLARUS:

- Monitor the individual exploitation activities, and push for concrete actions and collaborations e.g. for each organisation, a CLARUS ambassador can be identified that promotes CLARUS results to their institute colleagues and collaboration partners that they can reach.
- In each exploitation dimension (scientific, business, technical progress, knowledge gain, visibility, image/reputation), identify best practices and share them across the consortium. Develop business patterns that help partners to realise synergies between their post-project exploitation activities. These could include contract templates aimed at speeding up the negotiations related to access to background IP listed in the Consortium Agreement after the project has ended.
- Provide useful support, e.g., training, videos, events etc., helping CLARUS partners to achieve their individual exploitation goals. For example, for partners who want to have more visibility, CLARUS can provide platforms (website, social media channels, events, publications) allowing them to present their exploitation results. For partners who want to transfer the CLARUS results into business, the respective TEO development partner can provide documentation and training, or support with a testing environment for interested potential customers.

3.3. Joint Exploitation Strategies

The exploitation strategy of CLARUS is based upon the "Innovation Management for Practitioners – How to Convert Research into Commercial Success Story" report, issued by the European Commission aiming to tackle the European Paradox, namely a strong science base yet weak innovation performance, and has been tailored to the specificities, needs and results of the project. Throughout the tailoring process, the consortium paid special attention to the identified impact factors for market-oriented exploitation, and integrated these into its overall strategy, from setting up the consortium to support future commercialization to performing a preliminary market scan to identify the market targeted and the strength of the market demand.

The general objective of the joint exploitation strategy is to ensure the sustainability of the CLARUS TEOs. This is achieved through viable business models which are essentially based on the interests of the project partners and their willingness to contribute after the project ends. To have an insight into the partners' contribution plans, the current interests and opinions have been collected in a survey by asking the following questions:

- Is your organisation willing to contribute actively to the maintenance of one of the CLARUS TEOs after the project ends? Please specify which of the 3 TEOs (GD Index, Data Space, AI Toolkit) and indicate e.g., yes/yes, if… / no)
- Specify what this contribution could look like (time, money, expertise, specific tasks like software updates, bug fixing, user support, etc.)?
- What effort (in EUR or PMs per year) do you estimate for these activities?
- What role could you imagine in a potential "Operation Team" of one of the CLARUS TEOs (software development, support team, infrastructure provider, operator, hosting, other)
- Do you see your institution as an official (i.e., legal) part/partner of a future (legal) organisation of one of the CLARUS TEOs?

The results of the survey show that there is a high willingness to contribute to different kinds of activities after the project ends. Most of the partners are willing to contribute time and expertise in the field of maintenance which covers software updates, and bug fixes to keep the developed solutions up and running. Some partners are also showing their commitment by providing user support, further developments, and marketing activities. How much the contribution will be in terms of time (in person months) or money is very difficult to estimate by the partners at this stage. However, the estimated effort will be provided to a large extent in the form of in-kind contributions.

Many partners are also prepared to participate in various roles in a future operating organisation for the respective CLARUS TEO. These insights are a valuable foundation for the business model considerations in Task 2.3 as well as for the further development of the exploitation strategy and planning.

Summary of the results from the Joint Exploitation Survey

- Most (7 out of 9) of the partners are willing to contribute to CLARUS after the end of the project.
- The contributions are mainly in areas of maintenance and technical support such as software updates, bug fixing, further developments and technology transfer.
- Most of the partners have a clear idea of their role to sustain the developed CLARUS solutions after the project ends.
- 2 partners are willing to have an official role in the operation of one of the CLARUS solutions, 2 partners make it dependent on the maturity status reached and 5 partners answered "no" at this stage of the project.

Based on these results, the following recommendations for CLARUS should be considered:

- Identify mechanisms to sustain the project results after the project ends. This toolbox should consider all of the models that have been deemed successful, for instance, in the competitor analysis stage, and gauge their suitability for the specific CLARUS TEOs.
- Consider different governance models and organisational structures towards sustainability and exploitation. While the development has been done in a collaborative, federated fashion, there are parts of the sustainability challenges that are best addressed through a single legal entity e.g., by using spin-off mechanisms of CLARUS partners.

3.4. Intellectual Property Rights Management

All IPR-relevant topics are specified and defined in the Consortium Agreement (CA). The purpose of the Consortium Agreement is to establish a legal framework for the project in order to provide clear regulations

for issues within the consortium related to IP ownership, confidential information, Open-Source issues, standard contributions, and access rights to background and foreground intellectual property (IP) for the duration of the project and any other matters of the consortium's interest.

For the success of the project, it is essential that all project partners agree on explicit rules concerning IPR ownership, access rights to any Background and Foreground for the execution of the project and the protection of IPRs and confidential information before the project starts. Therefore, these issues are addressed in detail within the CA between all project partners as well as contractual obligations in the grant agreement. To ensure the smooth execution of the project, the partners agree to grant each other royalty-free access rights to their Back-and-Foreground for the execution of the project. Any details concerning the access rights to Back and Foreground after the duration of CLARUS are defined in the CA.

IP Ownership: Foreground shall be owned by the partner carrying out the work leading to such Foreground. If any Foreground is created jointly by at least two project partners and it is not possible to distinguish, such work will be jointly owned by the contributing project partners. The same shall apply while carrying out work on the project, an invention is made having two or more contributing parties contributing to it, and it is not possible to separate the individual contributions. Any such joint inventions and all related patent applications and patents shall be jointly owned by the contributing parties. Any details concerning the exposure to jointly owned Foreground, joint inventions and joint patent applications are addressed in the CA.

4. PESLTE Analysis

PESTLE is an analysis tool which helps to examine external events and influences regarding their effect on an organisation's performance. It gives a bird's eye view of the whole environment from many different angles on a certain idea, in our case on the future CLARUS solutions/results. PESTLE is an acronym that stands for Political, Economic, Social, Technological, Environmental and Legal factors (see Figure 6). All factors can affect the CLARUS developments in positive or negative ways.

Figure 6: PESTLE Factors

In a workshop setting during the plenary meeting in Valencia (Q1 2023) all present project colleagues collected possible influencing factors in the respective category. Colleagues who participated online were able to submit their contributions via an online collaboration tool (see Figure 7). The WP2 team documented, processed and consolidated the determined factors and classified them as positive or negative. A summary of the PESTLE factors is presented in Table 2.

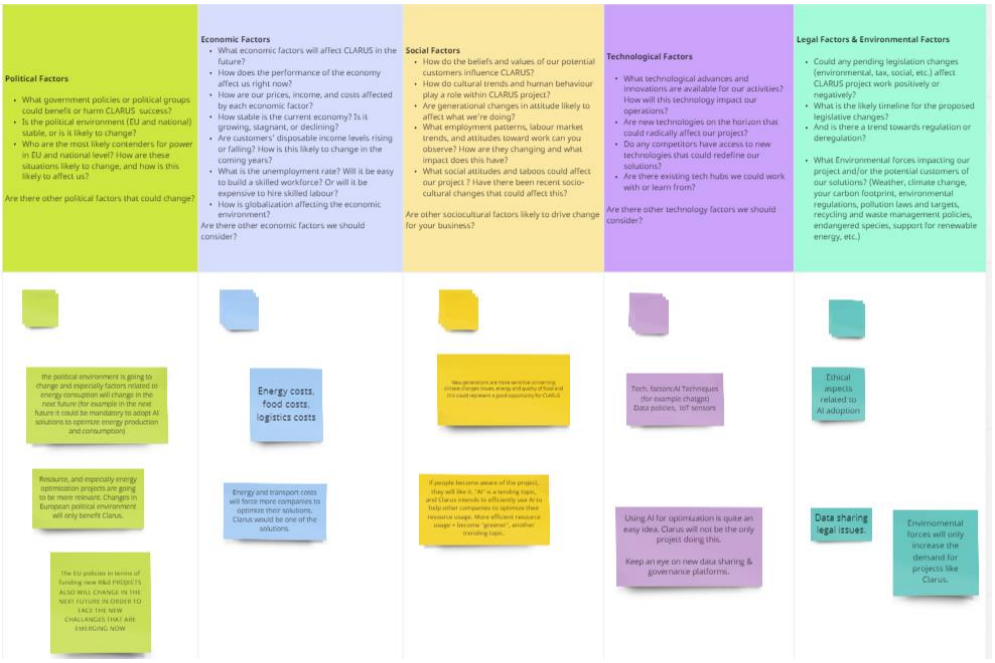

Figure 7: Screenshot of PESTLE online contributions

4.1. Political

These factors are influences which are determined by governmental decisions. They include, for example, environmental policies, trade regulations, financial and employment laws, etc. These factors strongly influence many aspects of an organisation's environment which are closely related to an organisation's internal process. This also includes the effects of the level of bureaucracy or the general stability of a government.

With regards to CLARUS, specifically, decisions made by the government (EU or national) are political factors e.g., the EU has strict regulations regarding food safety, labelling, traceability, and production standards. The use of AI in food processing must comply with these regulations, which can impact its adoption and implementation. The EU may provide incentives, funding, or supportive policies to encourage the use of AI in the manufacturing sector, including food processing. This can positively influence the integration of AI technologies.

Digital Transformation Initiatives: The EU government promotes and supports digital transformation initiatives, including the use of AI, to enhance competitiveness and innovation in the food industry. Policies and funding opportunities may be available to encourage AI adoption.

Data Protection Regulations: The EU has comprehensive data protection regulations, including the General Data Protection Regulation (GDPR). These regulations impose strict requirements on the collection, storage, processing, and sharing of personal data. Compliance with these regulations is essential for ensuring secure and privacy-preserving data usage in the food industry. The EU government supports initiatives that promote secure and privacy-preserving data usage. Funding opportunities, guidelines, and best practices may be available to encourage businesses in the food industry to adopt robust data protection measures.

EU Green Deal: The European Green Deal is an ambitious policy framework aimed at transforming the EU into a climate-neutral and sustainable economy. The usage of Green Deal Indices in the food industry aligns with the EU's political agenda and sustainability goals, making it a favourable option for businesses. The EU government may provide incentives, subsidies, and grants to encourage the adoption of sustainable practices in the food industry. Using Green Deal Indices can make businesses eligible for such support, facilitating the optimization of food industry processes.

4.2. Economical

Economic factors are in close relation with goods, services and money. They affect organisations directly (e.g., pricing strategies) as well as indirectly (e.g., inflation rate) through the general financial state of an economy. Examples of these components are interest rates, exchange rates, taxes and the level of demand and supply.

Cost and Investment: Implementing AI technologies in the food industry may require substantial investments in infrastructure, software, and skilled personnel. The economic viability of AI solutions, their return on investment, and the potential cost savings need to be considered. AI can enhance productivity, efficiency, and quality in food processing. EU manufacturers need to adopt AI technologies to stay competitive in the global market, especially considering the advancements in AI adoption by competitors.

Business Competitiveness regarding CLARUS Data Spaces: Demonstrating a commitment to secure and privacy-preserving data usage can enhance the reputation and competitiveness of food industry businesses. Consumers are increasingly concerned about data privacy, and companies that prioritise these aspects may gain a competitive advantage. Ensuring data security and privacy often requires investments in advanced technologies, secure infrastructure, encryption mechanisms, and skilled personnel. Companies must evaluate the economic feasibility of these investments while considering potential cost savings and long-term benefits.

Implementing Green Deal Indices in the food industry requires investments in renewable energy systems, sustainable production methods, waste reduction, and resource efficiency. The economic viability and return on investment of these initiatives need to be considered to ensure long-term profitability.
Market Demand: Increasingly, consumers are demanding sustainable and environmentally friendly products. Utilising Green Deal Indices in the food industry can help meet these demands and attract eco-conscious consumers, potentially leading to increased market share and revenue.

4.3. Social

These factors support the investigation of an organisation's social environment. Determining influencing factors in this area are, for example, cultural trends, demographics, immigration rates or the education level of the population. The focus of these elements lies in forces within the society which shape attitudes, opinions, and interests. They are strongly connected with family, friends, neighbours, or social media.

In terms of CLARUS AI-Toolkit the public perception and acceptance of AI in food processing may vary. Some consumers may have concerns about the impact on traditional methods, food safety, or job displacement. It is important to consider public opinion and address any potential resistance. Educating consumers about the benefits, safety, and ethical considerations of AI usage can promote acceptance and trust in AI-driven processes. AI implementation can impact the workforce by automating certain tasks. This may require reskilling or upskilling existing employees or changes in job roles. The impact on employment and the workforce needs to be considered and managed appropriately. The EU places importance on ethical considerations in technology adoption. Ensuring AI is used responsibly, with proper safeguards for privacy, data protection, and fair treatment of workers, is crucial to meet societal expectations.

With regard to CLARUS, Data Spaces privacy and data security are important factors influencing consumer trust. The EU population tends to prioritise data protection and may favour businesses that prioritise secure and privacy-preserving data usage. Communicating transparently about data protection practices can help build trust with consumers. Societal expectations in the EU emphasise the ethical use of data. The responsible handling of data, ensuring consent, and implementing anonymization techniques are important considerations when optimising data usage in the food industry.

Concerning GDI it can be stated that consumer attitudes toward sustainability and the environment are evolving. The usage of Green Deal Indices in the food industry can enhance a company's reputation and attract socially conscious consumers who prioritise eco-friendly products and practices. Utilising Green Deal Indices aligns with societal expectations for responsible and sustainable business practices. Demonstrating a commitment to environmental stewardship can improve public perception and brand loyalty.

4.4. Technical

Technological factors concern innovations in technology. They determine the existence, availability and development of technology. Areas strongly connected to these factors are automation, research & development and the general technological awareness a market possesses. They strongly influence decisions made with regard to which technologies businesses choose or have to invest in, in order to stay up-to-date or to become a leader in their field.

The availability and advancement of AI technologies, including machine learning, computer vision, and robotics, can impact the optimization of food processing. Access to state-of-the-art AI tools and platforms is essential for effective implementation. Keeping up with the latest technologies and leveraging them effectively can drive innovation and efficiency. AI relies on vast amounts of data for training and decision-making. Ensuring access to quality data, data privacy, and the necessary connectivity infrastructure is crucial for successful AI implementation in the food industry.

Utilising encryption techniques and anonymizing personal data can help protect sensitive information during data sharing and analysis. Implementing state-of-the-art technologies and industry best practices is essential to maintain data security. Building secure infrastructure and networks, including firewalls, intrusion detection systems, and secure cloud platforms, can safeguard data during storage and transmission. Adopting robust security measures is crucial to protect data from unauthorised access or cyber threats.

Implementing Green Deal Indices often involves adopting advanced technologies, such as renewable energy systems, energy-efficient machinery, waste reduction technologies, and sustainable packaging solutions. Access to and integration of these technologies are crucial for optimising food industry processes. Green Deal Indices may require the collection and analysis of environmental data related to energy consumption, greenhouse gas emissions, waste generation, and water usage. Implementing robust data management systems and analytical tools is essential for effective monitoring and decision-making.

4.5. Legal

Legal factors refer to laws and legislation that can affect how an organisation operates. They include transversal legal areas such as trade regulation, employment legislation, consumer rights or more domain-specific legislation such as health and safety guidelines. Laws and legislation can be adopted and enforced at various levels: international, European, national, or even local. Besides, legal factors are closely associated with ethical standards which influence stakeholders' perception of the organisation. Finally, it should be noted that political and legal factors sometimes intersect, since one of the main roles of any government is to legislate.

Protecting AI-related intellectual property, such as algorithms, models, and proprietary software, is crucial to incentivise innovation and investment in the food industry. Companies must ensure compliance with intellectual property laws and establish mechanisms for safeguarding their AI assets. The use of AI involves processing and analysing vast amounts of consumer data. Compliance with EU data protection regulations, such as the General Data Protection Regulation (GDPR), is paramount to protecting individuals' privacy rights and maintaining data security.

Concerning CLARUS Data Spaces: Sharing data between different stakeholders in the food industry requires well-defined legal agreements and contracts. These agreements should outline the purpose, scope, and restrictions on data usage, ensuring compliance with relevant data protection regulations. If data is shared

or processed outside the EU, companies must comply with regulations governing international data transfers, such as implementing appropriate safeguards, using standard contractual clauses, or relying on approved mechanisms like Privacy Shield (if applicable).

Regarding CLARUS GDI: The EU has environmental regulations and standards that businesses must comply with. Utilising Green Deal Indices helps ensure compliance with these regulations and demonstrates a commitment to sustainability, reducing the risk of legal penalties and reputational damage. Green Deal Indices may require businesses to report their environmental performance and progress. Adhering to reporting obligations provides transparency and accountability, promoting compliance with EU regulations.

4.6. Environmental

The Environmental factors include all those aspects that are determined by the surrounding environment such as climate, weather, geographical location etc. Also, elements that influence ecology are part of these components; they include, for example, natural resources, waste disposal or recycling.

The EU promotes sustainability and circular economy principles. AI can contribute to reducing food waste, optimising energy consumption, and improving supply chain efficiency. Integrating AI with sustainable practices aligns with EU environmental objectives. Considering environmental impact when optimising data usage is crucial. Adopting energy-efficient hardware, optimising data storage and processing methods, and promoting sustainable practices in data centers can contribute to minimising the environmental footprint of data-intensive processes.

Climate Change Mitigation: The usage of Green Deal Indices in the food industry contributes to mitigating climate change by reducing greenhouse gas emissions, optimising energy usage, and minimising waste. Aligning food industry processes with environmental objectives helps preserve natural resources and biodiversity.

4.7. Conclusion and relevance for CLARUS

Table 2 provides a compact overview of all detected factors for each category. The political and economic factors show a rather balanced relationship between positive and negative. From today's perspective, it is difficult to judge which of the positive or negative factors will have more significance in the future. The many positive ones in the field of technology should not obscure technical trends that can become relevant very quickly. It would be very difficult for CLARUS to pick up on these fast enough. For this reason, the consortium and especially the technical development partners must keep a very close eye on them. Since social factors tend to have a long-term effect, it is unlikely that they will have a rapid effect, either positive or negative. Nevertheless, it is pleasing that the positive factors were found to outweigh the negative.

It is important to note that the specific factors and their impact may vary across EU member states and regions. Additionally, addressing the ethical, social, and legal implications of AI adoption in the food industry is crucial to build trust and ensure responsible implementation. Businesses in the food industry need to prioritise data protection and privacy-preserving practices to comply with EU regulations, gain consumer trust, and maintain a competitive edge. Implementing robust security measures, complying with legal requirements, and aligning with societal expectations are key steps towards secure and privacy-preserving data usage in the food industry.

Implementing Green Deal Indices in the food industry allows businesses to actively contribute to the EU's sustainability goals, respond to market demands, and comply with regulatory frameworks. It is essential to consider the economic feasibility, technological advancements, and societal expectations while integrating Green Deal Indices into food industry processes.

POLITICAL + EC committed to Green Deal, SDG policies → strict regulations + EC promotes digital transformation including AI and Data Spaces + EU-wide eco-friendly policies and groups + EC committed to support diversity + EU could ask for fulfilment of specific GDI ~ AI regulations (EU AI-Act) - Energy policies and supply affected by crisis (Ukraine war) - Groups / political parties that deny climate change - Different national AI regulations (different paces) - CLARUS AI solutions must comply with EU/national AI-regulations	**ECONOMICAL** + AI solutions can enable improved efficiency, quality, and customer experience in the food industry + Using AI and DS techs can provide a competitive advantage (reputation) + High energy prices increase the demand for CLARUS solutions - High interest rates, economic instability - Implementing AI technologies, DS and GDI in the food industry may require substantial investments in infrastructure, software, and skilled personnel - No or slow economic growth causing pressure on getting financial support for investments
SOCIAL + AI has the potential to generate new jobs + Customer behaviour is changing in the direction of bio-production and responsible use of resources + Young generation is more aware/sensitive/interested on climate change and sustainability + Privacy and data security are important factors influencing consumer trust. + Green Deal Indices in the food industry can enhance a company's reputation - AI can impact workforce by automating certain tasks → job losses, reskilling or upskilling needed - People are afraid of AI (black box) → may cause resistance	**TECHNOLOGICAL** + New technologies such as generative AI (text and image) and quantum computing + Convergence between digital and green transition → new digital technologies support sustainability + Advances in sensors allow to measure everything + AI gets industrialised → easy to deploy and integrate + Data storage and computation power getting cheaper and are available everywhere + Data Spaces enabling secure and privacy-preserving data sharing + New recycling technologies are in development - Broadband availability in rural areas - Insufficient data quality - Lack of available training data

- Consumers are increasingly concerned about data privacy and data protection → resistance to share data	- Keeping up with the latest technology developments (high pace)
LEGAL + Well-defined legal agreements and contracts may enforce data sharing between different stakeholder in the food industry + Carbon tax policies may increase the demand for CLARUS TEOs - EU gets over-regulated → competitive disadvantage - Uncertainties concerning EU AI-Act	**ENVIRONMENTAL** + Generational shift towards more responsibility for the environment + EU promotes sustainability and circular economy principles + Green Deal Indices in the food industry contributes to mitigating climate change - Large CO_2 footprint of server operation, data storage and processing methods

Table 2: Summary of PESTLE factors

The results of PESTLE analysis will be included and further processed in the SWOT analysis (see chapter 6).

5. Competitor Analysis

The competitor analysis allows us to identify and understand competitors' strengths and weaknesses in relation to CLARUS offers. The analysis helps to recognize the needs of potential users and to learn how they rate the competition. Most importantly, the competitor analysis is a mechanism to develop effective competitive strategies and provides insights into what gives CLARUS an advantage over the target market. Moreover, it aims to clearly distinguish CLARUS solutions from competitors.

5.1. Identifying Relevant Competitor

The list of existing competitors, market companions or inspiring and interesting solutions related to our CLARUS Tangible Expected Outcomes (TEO) was created in collaboration with the project members of WP2. The partners were asked to identify (e.g., through a web search, their professional experience, asking colleagues etc.) existing examples/solutions for our 3 defined CLARUS TEOs (Green Deal Index, Data Space, AI Toolkit) and insert them into the provided table (separate spreadsheets for the 3 CLARUS TEOs).

Collection:
Through contributions from all partners, the following competitors or inspiring examples have been identified.

- 14 Green Deal Index competitors/examples
- 11 Data Space competitors/examples
- 17 AI Toolkit competitors/examples

After the collection, the partners were requested to prioritise (1-3) the identified competitors/examples in order to select the most relevant and interesting for CLARUS and the subsequent analysis process.

Selection:
For the subsequent analysis, the competitors/examples rated with prio 1 and 2 have been selected which leads to the below list.

- 11 Green Deal Index competitors/examples
- 8 Data Sparce competitors/examples
- 8 AI Toolkit competitors/examples

5.2. Analysis

The project members of Exploitation and Sustainability WP2 evaluated the twenty-seven platforms through web-based research and documented the results in a provided template (see Appendix). The template is structured according to a basic business model view. It describes what value the platforms offer its customers (value proposition), how this value is created (value creation) and how the platforms generate profits/cover costs from its activities (value capturing). Furthermore, the analysis also covers organisational insights (board, team, legal form, etc.), strengths & weaknesses as well as impressions on usability and user experience (if available). The twenty-seven completed analysis documentations were transferred into a summary table and evaluated through qualitative content analysis. Figure 8 shows some logos of the analysed solutions.

Figure 8: Selection of analysed competitors

5.2.1. Analysis Results for Clarus Green Deal Index

The analysis for Green Deal Indices covers the solutions/examples listed in Table 3 and includes three different categories: Scientific Publications (7), Existing Indices (3) and one Standardisation Organisation. Since there are not yet many existing indices, we have focused our analysis on current (scientific) publications. In the following, we provide insight into the highlights and learnings of selected studies. In the area of existing indices, we present the Environmental Performance Index (EPI) in detail, as it is considered one of the most comprehensive and influential environmental performance indices in the world.

Name	Weblink	Category
A systematic literature review of life cycle	https://www.sciencedirect.com/science/article/abs/pii/S026087741930024X?via%3Dihub	Scientific Publication
Digital Adoption Index	https://www.worldbank.org/en/publication/wdr2016/Digital-Adoption-Index	Existing Index
Effects of Dutch livestock production on human health and the environment	https://www.sciencedirect.com/science/article/pii/S0048969720332228?pes=vor	Scientific Publication
Ecological footprint assessment and its reduction for industrial food products	https://www.tandfonline.com/doi/full/10.1080/19397038.2019.1665119	Scientific Publication
Environmental Performance Index	https://epi.yale.edu/	Existing Index
Exergetic indicators in the food industry	https://doi.org/10.1080/10408398.2014.975335	Scientific Publication
GRI Standards	https://www.globalreporting.org/	Standards Organisation
IBM Global AI Adoption Index	https://www.ibm.com/watson/resources/ai-adoption	Existing Index

ITACA Food: A Model to Certificate the Sustainability of Food Processing Facilities	https://www.mdpi.com/2071-1050/11/17/4601	Scientific Publication
FAO Integration of environment and nutrition in life cycle assessment of food items: opportunities and challenges	https://www.fao.org/documents/card/en/c/cb8054en/?utm_source=twitter&utm_medium=social%2Bmedia&utm_campaign=faoknowledge	Scientific Publication
Environmental indicators for sustainability assessment in edible oil industry based on Delphi method	https://www.sciencedirect.com/science/article/pii/S266679082200163X?via%3Dihub	Scientific Publication

Table 3: Analysed Green Deal Index Examples

Highlights and Learnings from analysed publications:

Exergetic indicators in the food industry (Origin: Laboratory of Food Process Engineering, Wageningen University, The Netherlands, 2016)
The goal of this study was to evaluate the usefulness of Exergy Analysis as a sustainability assessment tool and to present the most common exergetic indicators used in the food industry.
Learning for CLARUS: The paper presents an alternative way to assess sustainability with respect to LCA and provides many points for reflection regarding the analysis of food industries. We will evaluate the possibility to include exergy analysis in CLARUS Green Deal Performance Assessment methodology.

Ecological Footprint Assessment and its Reduction for industrial food products (Origin: National Institute of Food Technology Entrepreneurship and Management, Sonipat, India, 2019)
This research proposes a method to evaluate the ecological footprint of food products and then analyses potential solutions on how to reduce this impact. The total ecological footprint is divided into energy consumption, material consumption, waste generation, transportation, water consumption, manpower and direct land consumption. This paper is an attempt to summarise the impacts of food production into a single metric that is useful for evaluating alternatives and making comparisons with benchmarks. In addition, such an analysis can identify hotspots in terms of environmental impact so that weaknesses in the production process can be addressed directly. In the case of a food industry with a wide range of products, the environmental footprint can be used to assess which food has the greatest impact.
Learning for CLARUS: This study highlights the large number of factors that influence a food's environmental footprint; however, the authors attempt to summarise a detailed analysis into a single metric that is easy to use and understand. This approach is also a conceivable possibility for the CLARUS GDI.

ITACAFood: a model to certificate the sustainability of food processing facilities (Origin: Department of Agriculture, Università degli Studi Mediterranea di Reggio Calabria, Reggio, Italy, 2019)
The paper proposes a specific model to evaluate the sustainability performance of buildings dedicated to food processing. Starting from current evaluation models which focus on energy efficiency and emissions related to the building itself, the authors try to broaden the perspective and develop a tool more specific for food processing facilities. The tool takes into account, in particular, the well-being of workers and specific protocols that food must meet. The model results in a single score that allows the building's performance to be evaluated. The paper proposes the application of the tool to an existing food factory and provides a comparison between the score obtained with the improved metric and the traditional metric.
Learnings for CLARUS: The proposed metric is easy to calculate, and the uniform final score simplifies comparison across facilities. It can be used to evaluate alternatives or compare performance against a benchmark. In addition, the methodology is general enough to evaluate food processing facilities in different countries by fine-tuning the weighting of the criteria.

Integration of environment and nutrition in life cycle assessment of food items (Origin: Food and Agriculture Organisation of the UN, 2021)
The publication provides an overview of LCA techniques adopted in the context of food items and a description of possible improvements and suggestions for further research. The main concepts are nLCA (nutritional life cycle assessment) and nFU (nutritional functional unit), which are fundamental to relate the environmental impact and nutrition potential of food items. The solution provides a distinction between nutrients to be promoted and nutrients to be restricted and explains how to determine the nutrient quality of foods. In addition, an impact category analysis is performed to determine how the choice of different nFUs affects LCA results in terms of both environmental and human health impacts.
Learnings for CLARUS: The most important message is that a specific framework is needed for conducting life cycle assessments of food. In addition, the importance of the nutritional aspect of food should not be lost in the analysis of environmental impacts. The main objective of sustainable development in the food sector should be to feed the world's population adequately, with the least possible impact on the environment.

Analysis results of existing Indices: The Environmental Performance Index (EPI)

The Environmental Performance Index (EPI) was first introduced in 2006 by a team of researchers from the Yale Center for Environmental Law & Policy and the Columbia Center for International Earth Science Information Network (CIESIN) at Columbia University. The EPI was created as a response to the need for a comprehensive and unbiased assessment of countries' environmental performance and as a tool to help identify areas where countries need to improve. The EPI 2022 framework organises 40 indicators into 11 issue categories and three policy objectives, with weights shown at each level as a percentage of the total score (see Figure 9)

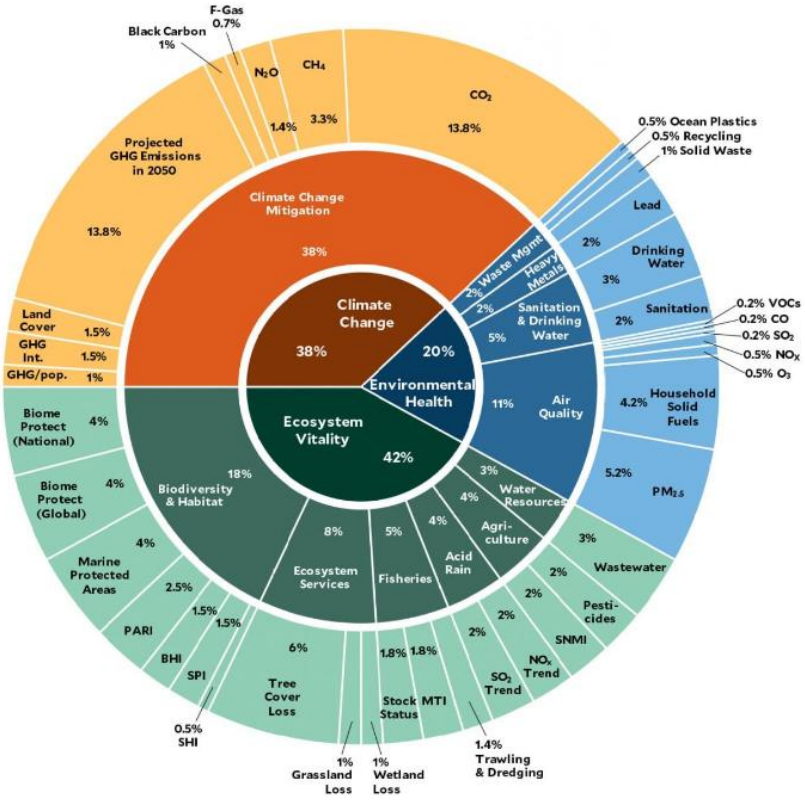

Figure 9: EPI Framework 2022

The Environmental Performance Index (EPI) provides several important services to a range of stakeholders:

- Assessment of environmental performance
- Informing policy and decision-making
- Benchmarking progress
- Raising awareness
- Encouraging transparency and accountability

The EPI is made available by a non-profit organisation led by CIESIN and is a collaborative effort that involves partnerships with organisations, institutions, and experts from around the world, including government agencies, international organisations, academic institutions, and environmental groups. The organisation is governed by a steering committee, which is chaired by CIESIN and includes representatives from partner members. Funding for EPI is based primarily on a combination of philanthropic contributions, foundation grants, and government funding.

The EPI is made available to the public free of charge at: https://global-reports.23degrees.eu/epi2022/root The results are provided in the form of reports, data sets, and online tools that are accessible to anyone who is interested in environmental performance. The provided interactive dashboards (see Figures 10 and 11) can be seen as a best practice example.

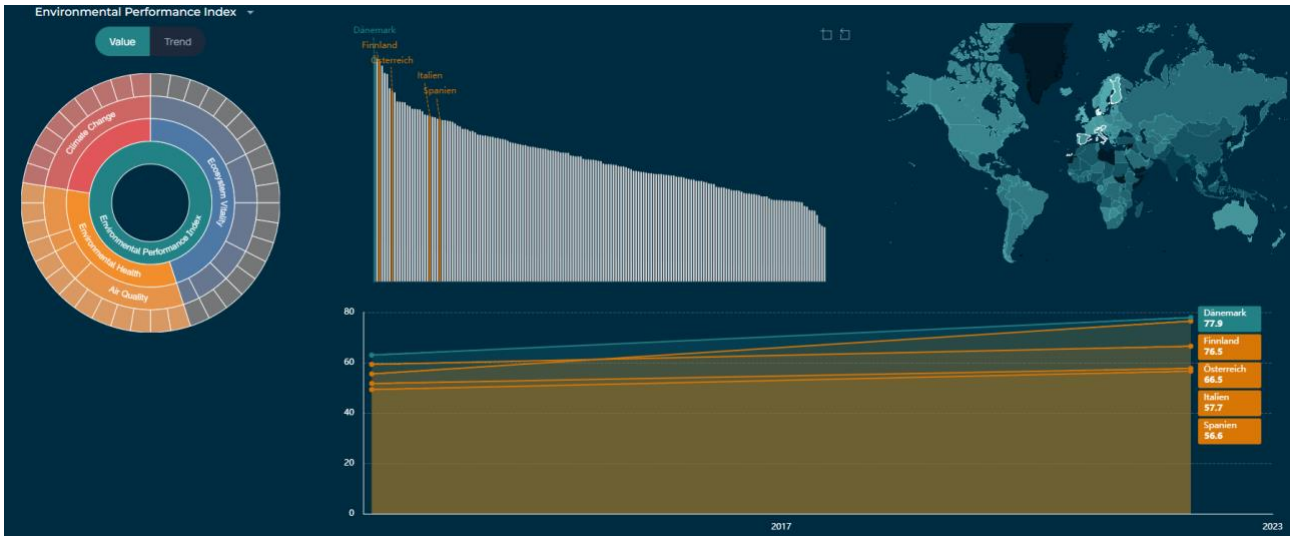

Figure 10: EPI Dashboard - overall view

The usability of the EPI dashboard is outstanding. The navigation is easy to understand, and the performance is excellent. The interface is useful and well-organised.

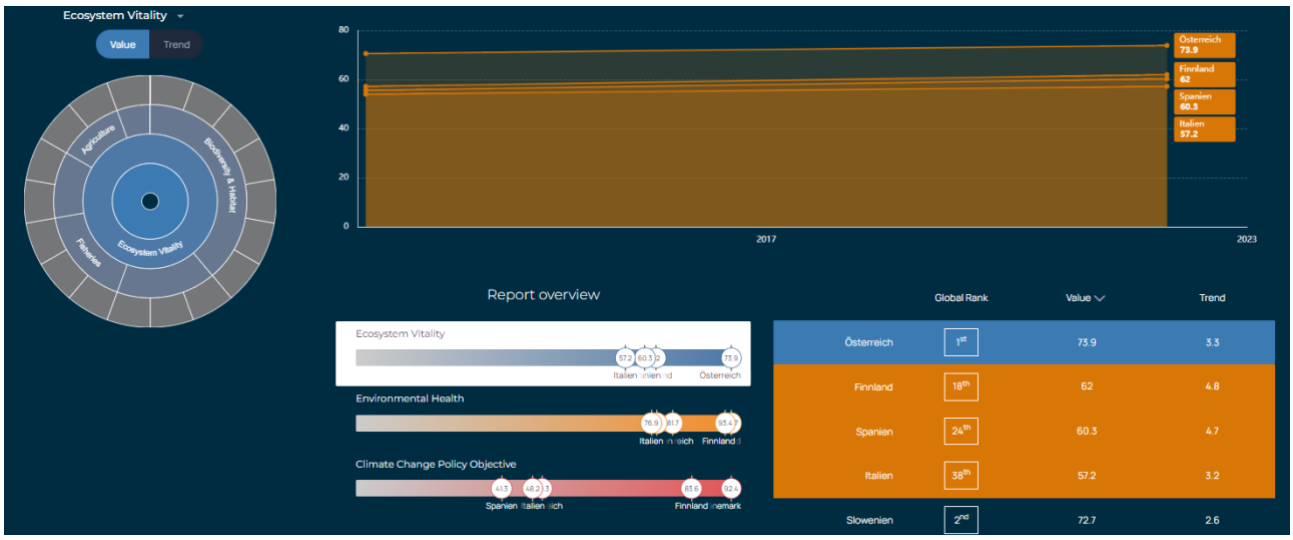

Figure 11: EPI Dashboard - ecosystem visibility

Furthermore, it is possible to download the (selected) data and there are several ways of creating customised charts and graphs (see Figure 12).

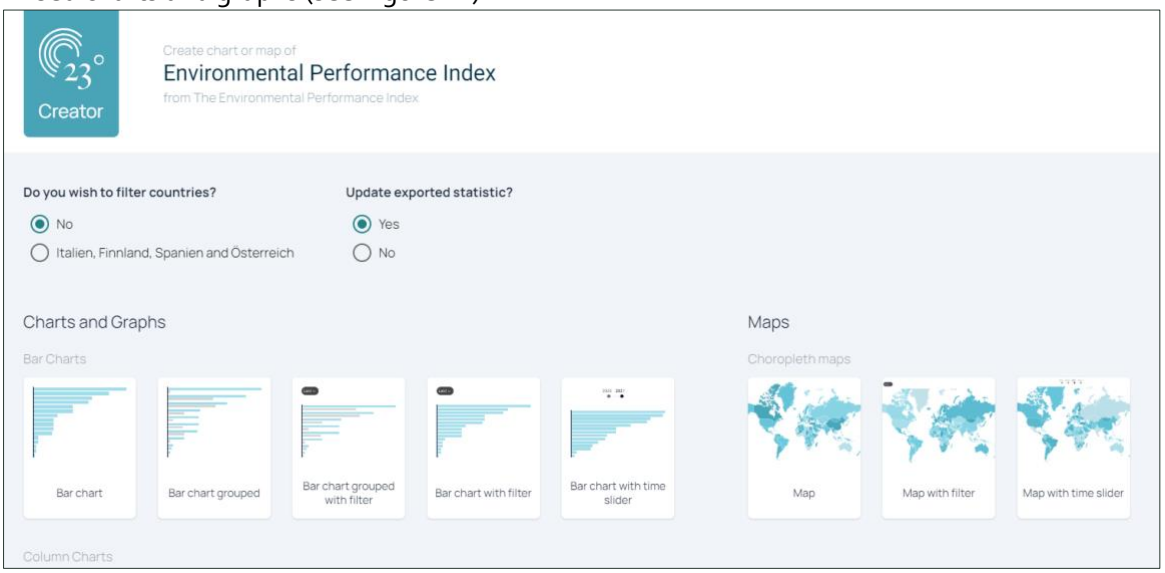

Figure 12: EPI Dashboard - Chart and Graph creator

Learnings for CLARUS: The EPI is widely cited in academic research, policy discussions, and media reports, and is used by a range of stakeholders, including governments, international organisations, and environmental groups, to assess and track environmental performance at the national and global levels. Therefore, it could be a useful reference for comparing the impact of different alternatives towards improving the sustainability of an organisation. The map visualisation is probably more applicable for large organisations but could also be used or tested for both CLARUS pilots. The other dashboards, particularly the ranking visualisations could be used as a reference. In general, the EPI is a very good example of how a performance index can be built from individual objectives and also, we can gain valuable lessons about usability and UX.

5.2.2. Analysis Results for CLARUS Data Space

The analysis for Data Spaces covers the solutions/examples listed in Table 4 which includes 1 Commercial Data Platform, 1 Data Space, 2 Data Space Projects, 2 Data Space Component Providers, and 2 Standardisation and Infrastructure providers.

Name	Weblink	Category
Agri Data Space	https://agridataspace-csa.eu/	Data Space Project
DAWEX	https://www.dawex.com/en/	Commercial Data Platform
Eclipse Data Space	https://projects.eclipse.org/projects/technology.edc	Data Space Component Provider
Environmental Data Spaces	https://environmentaldataspace.com/	Data Space
Fiware	https://www.fiware.org/	Data Space Component Provider
GAIA-X	https://gaia-x.eu/	Standards & Infrastructure
Green Data Hub	https://www.greendatahub.at/?lang=en	Data Space Project
International Data Spaces	https://internationaldataspaces.org/	Standards & Infrastructure

Table 4: Analysed Data Spaces

Due to the variety of categories, it is not meaningful to compare the different solutions or examples. Therefore, we decided to outline CLARUS relevant aspects or "best practices" from each category.

The **Agri Data Space** is an actual running EU project (started October 2022) which aims to create a European framework for a secure and trustworthy data space in agriculture.
***CLARUS relevance**:* The project should be monitored, and project partners should be contacted to gain further insights and eventually establish cooperation with CLARUS.

DAWEX was one of the first commercial Data Sharing Platforms (established in 2015 in France). Its mission is to facilitate and accelerate secure data circulation between economic stakeholders, institutions, and private organisations, contributing to the development of the data economy. DAWEX focuses on companies interested in secure data exchange all over the world, offers secure and controlled data exchange technologies, and furthermore helps establish data marketplaces with its technology.
Strengths: Tested technology for secure and controlled data exchange and for establishing a marketplace for data sharing.
Weaknesses: Use of proprietary technologies for data exchange.
***CLARUS relevance*:** DAWEX was definitely a pioneer in the field of data-sharing platforms based on state-of-the-art technologies. We should have a close look into DAWEX UX/UI in order to design a user-friendly and easy-to-use UI for the CLARUS data space. Since DAWEX managed the transition from a start-up to a profitable company, valuable inputs for a viable business model can be derived.

FIWARE was created to build an open sustainable ecosystem around public, royalty-free and implementation-driven software platform standards. The main aim is to ease the development of smart solutions and support organisations in their transition into smart organisations. FIWARE brings the essential Building Blocks helping to create Data Spaces enabling access and sharing of data in an effective and trustworthy manner.

Organisation: FIWARE was founded in 2016, in a few years it reached a worldwide dimension, comprising more than 90 member organisations, including large corporations, SMEs, technology centres and universities, and hundreds of individual members.
Strengths: Guarantees interoperability, sovereignty, and trust, provides concrete tools to enable data sharing using standard APIs and OS components.
CLARUS relevance: Partners in the Consortium have a strong partnership with the FIWARE Community. Their expertise in its principles and tools should be utilised.

The mission of the **International Data Space Association (IDSA)** is to create a secure, trusted, and interoperable platform for exchanging and utilising data, in order to support innovation and economic growth. The IDS provides a framework for the creation of data spaces and data services that allow organisations and individuals to access and use data in a secure and controlled manner.
Data Monetization: The IDS provides a framework for monetizing data, enabling organisations and individuals to share and sell their data in a secure and trusted environment.
Data Analytics: The IDS provides tools and services for analysing and visualising data, enabling users to gain insights and make informed decisions based on their data.
CLARUS relevance: Reference European framework for data spaces. Specifically mentioned in the description of action. CLARUS should align the data space design and definitions to IDS.

The mission of the **Environmental Data Spaces** Community (EDSC) is to apply International Data Space standards and principles to environmental data, to increase the availability of high-quality data for any type of private or public decision-making that impacts the environment. They see themselves as an essential part to build the Green Deal data space that is part of the European data strategy. They consider their work successful when sustainable, effective data ecosystems are forming around this data space.
Strengths: the mission and the approach of the ESDC are appealing, the current activities do have substantial overlaps with the CLARUS data space, and already established collaboration with IDSA.
Weaknesses: no testing possibilities right now, no information on what is available at what point in time.
***CLARUS relevance*:** the role and engagement definitions are interesting, the collaboration with IDSA, it would be interesting to get in contact with this initiative in terms of joining forces.

5.2.3. Analysis Results for CLARUS AI Toolkits

The analysis for CLARUS AI Toolkits covers the solutions/examples listed in Table 5 which includes a broad range of categories starting from (EU) Projects (3), Start-Ups (2), SME (1), Large Enterprise (1) and a R&D Company. Due to the small number of examples per category, a comparison within the categories is not meaningful. For this reason, we have decided to select the most relevant examples based on the personal rating (1=very bad, 10=best in class) of the analysts.

Name	Weblink	Category
Metron	https://www.metron.energy/	SME
CYBELE	https://www.cybele-project.eu/	EU-Project
AI Toolkit	https://ai-toolkit.blogspot.com/	Project
KYKLOS 4.0 Cognitive ToolKit (KCTK)	https://kyklos40project.eu/components/	EU-Project
EMERSON	https://e360blog.emerson.com/applying-artificial-intelligence-to-commercial-refrigeration/	Large Enterprise
Nista	https://www.nista.io/	Start-Up

Raingers	https://raingers.ai/en/index.htm	Start-Up
ZDMP AI-Analytics runtime	https://software.zdmp.eu/docs/components/platform-tier/ai-analytics-runtime/	R&D Company

Table 5: Analysed AI Toolkits

Both analysed EU Projects CYBELE (started in 2019) and KYKLOS 4.0 (started in 2020) are interesting and relevant for the CLARUS project.

CYBELE aims to generate innovation and create value in the domain of agri-food by implementing Precision Agriculture (PA) and Precision Livestock Farming (PLF) methods, and to empower capacity building within the industrial and research communities associated with these domains. CYBELE is expected to contribute to the core Digital Single Market (DSM) Strategy pillars: Digitisation of industry, Cultivation of Digital skills, and Development of a European Open Science Cloud, High-Performance Computing and a European Data Infrastructure. Within the project, 9 different demonstrators have been developed.
CLARUS relevance: The role and engagement of Pilots and real Use Cases are a core aspect of this R&I project and can represent a valid example to be followed in CLARUS. In addition, the approach adopted for the financial/business impact can also inspire CLARUS activities.

The **KYKLOS 4.0** Cognitive ToolKit (KCTK) is a framework offering a bunch of modules and functionalities enabling advanced data analytics for Industry 4.0 and leading to more informed decisions. The developed toolkit can be used to simulate different scenarios based on production cost reduction, materials reuse or energy savings to promote a sustainable and circular economy. Although this toolkit is developed to address the needs of the KYKLOS 4.0 ecosystem, many parts of it are generic and can be applied to a broader context. Thanks to the digitalisation of manufacturing processes and the use of sensors, a huge amount of data is generated. Analysing this data and providing insights will help in optimising the processes and predicting failures of the machines on the shop floors.
CLARUS relevance: As the solution is still not available and the focus is on smart manufacturing and predictive maintenance, we can look at the KYKLOS 4.0 Cognitive ToolKit (KCTK) as an example for the design and development phases adopting a similar approach in the data analysis and ML algorithms identification.

Metron (SME)
Metron's ambition is to be the essential disruptive platform to orchestrate all the actors of the "Energy Cloud 4.0". Metrons sees itself as a Digital Energy Platform Orchestrator. Their core value revolves around the digitization of energy, transaction automation, ubiquitous communications, IT/OT convergence, data analytics and smart asset networks. Metron offers a SAAS platform with the following key functionalities:

- Data Acquisition Management
- Energy Performance Monitoring
- Energy Insights & Analytics
- Advance Energy Optimization
- Carbon Impact Tracing
- Energy Cost Management

With these services Metron focuses on the world market in domains such as Cement, Food & Beverage, Glass, Iron & Steel, Paper, Retail and Public Markets. Metron's approach is to go beyond the implementation phase (guarantee a fast and efficient implementation) and provide continuous support by delivering Energy and Data Science Expertise over several months (see Figure 13). Metron follows the DMAIC methodology: Define, Measure, Analyze, Improve and Control.

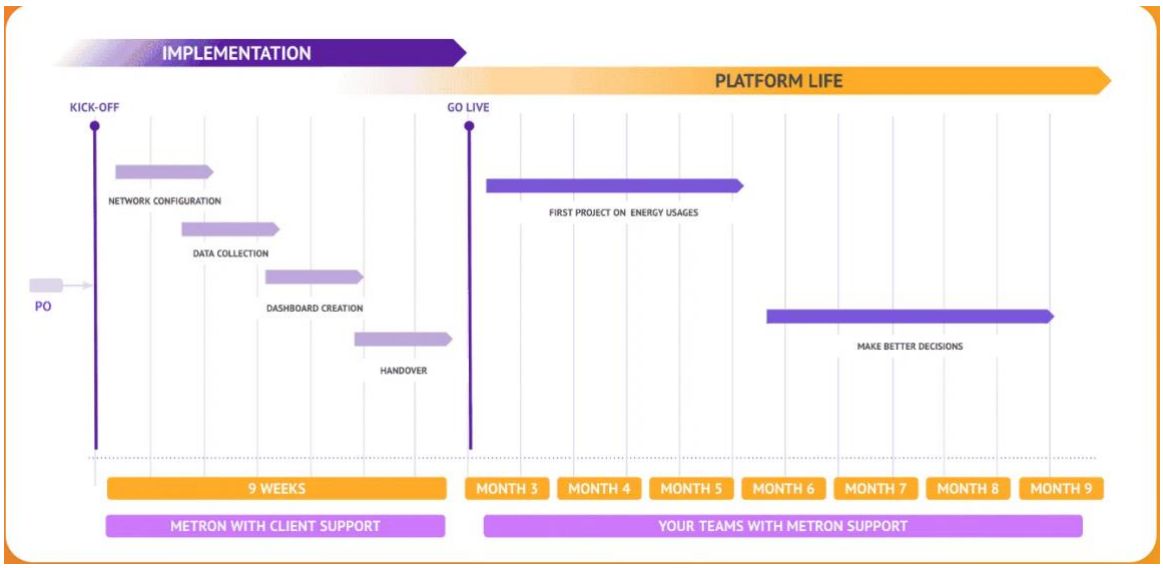

Figure 13: Metron's Service Approach

Strengths: long-time (10 years) commercial supplier for energy management and optimization, worldwide appearance, covering most important (energy intensive) sectors, covering the entire data value chain on energy data from data acquisition, data monitoring, analytics, optimization, impact tracking to cost management, additional offerings such as blogs, webinars, use cases and studies.

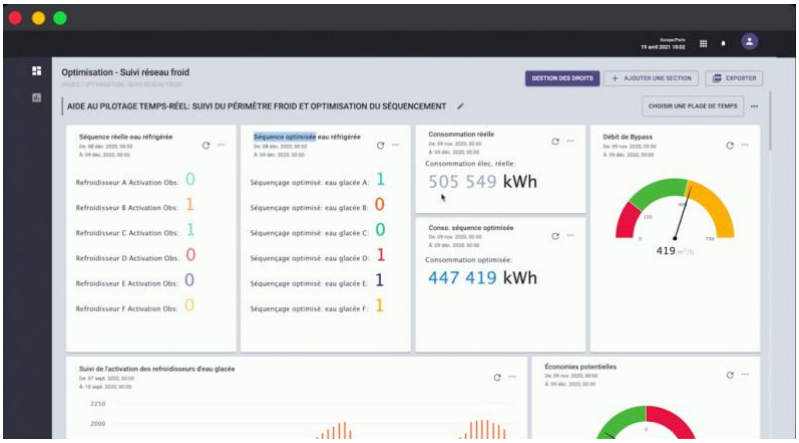

Figure 14: Metron's Dashboard for Detecting Consumption Drifts in Real Time

*Weaknesses: n*o explicit mention of AI and AI-related functions and features, no Data Space ambitions so far.
CLARUS relevance: Metron is a successful player in the global market and can serve as a "best practice" example for many CLARUS relevant fields e.g., the breakdown of offerings along the data value chain, the implementation plan, the provided case studies and webinars, and the business model.

EMERSON (AI for refrigeration)
Emerson is a well-established and respected player in the refrigeration industry, offering innovative and high-quality products and solutions. Emerson provides a range of intelligent solutions for commercial refrigeration service, aimed at improving the efficiency, performance, and reliability of refrigeration systems. Some of the key features and benefits of Emerson's intelligent solutions for commercial refrigeration include Real-time Monitoring and Control, Energy Efficiency, Predictive Maintenance,

Enhanced User Experience and Remote Access. They are leveraging AI and ML to optimise critical aspects of their customers' operations. Their solutions utilise sensors that deliver data to powerful control devices and integrate with advanced, cloud-based software. By leveraging the deep domain expertise of their refrigeration engineers, they are able to create data models that maximise refrigeration performance and help our customers to achieve a variety of key food retail and food service objectives.
CLARUS relevance: The Emerson solutions show that there is a clear market need for a) Monitoring and control b) predictive maintenance and c) AI-based energy efficiency in the sector. CLARUS should position itself as an alternative player, based on standards to ensure interoperability with a wider range of refrigeration system providers.

5.3. Conclusion

The analysed examples in the field of GDI, in particular the current publications, show multiple possibilities how the Green Deal performance can be assessed, and which aspects should be taken into account for the CLARUS version. Of course, traceability, simplicity and availability (quantity and quality) of the required data are important. Besides these aspects, the example of the EPI also shows the importance of an appealing presentation/visualisation of the data e.g., via interactive dashboards. This includes good usability and user experience. The EPI dashboard can be cited as a very good example for this purpose.

In the Data Spaces area, there is a wide range of learning for CLARUS. We should keep a close eye on the EU project Agri Data Space and possibly strive for cooperation. The same applies to the already existing Environmental Data Space. Especially interesting are the role and engagement definitions, and the collaboration with IDSA. As far as the data space component providers FIWARE and ECLIPSE are concerned, it is reasonable to use the standardised components offered by them. In addition, there are partners in the Consortium that have strong partnerships with the FIWARE Community and expertise in its principles and tools. From DAWEX, one of the few commercially successful data-sharing platform providers, we should look in detail at their UX/UI in order to design a user-friendly and easy-to-use UI for the CLARUS data space. Since DAWEX managed the transition from a start-up to a profitable company, valuable inputs for a viable business model can be derived.

The AI toolkit arena is certainly where the most players are in the game, and thus where the most competition exists. This ranges from similar EU projects to SMEs to very successful large companies. Thus, it is important that we find a promising niche for the CLARUS offering and then fill it with a useful and easy-to-use service.

In general, the analysis shows that there are separate market potentials for all three segments of CLARUS TEOs. A unique selling proposition can be created by combining two or all three TEOs, as this has not yet been available on the market.

6. SWOT Analysis

SWOT (strengths, weaknesses, opportunities, and threats) analysis is a framework used to evaluate an organisation's competitive position and to develop strategic planning. SWOT analysis assesses internal and external factors, as well as current and future potential. Strengths describe what an organisation excels at and what separates it from the competition. Weaknesses stop an organisation from performing at its optimum level. They are areas where the business needs to improve to remain competitive. Opportunities refer to favourable external factors that could give an organisation a competitive advantage. Threats refer to factors that have the potential to harm an organisation. Strengths and weaknesses are frequently internally related, while opportunities and threats commonly focus on the external environment.

Within the CLARUS project, we use the SWOT analysis to derive strategic directions and get the first building blocks for sustainable business scenarios for CLARUS TEOs. In order to get the appropriate input for the four SWOT categories, the WP2 team discussed the below questions for each category within WP2 coordination calls. The results of this process are shown in Table 5.

Strengths:

- What can we do better than anyone else?
- What advantages do CLARUS project solutions (our future services) have?
- What assets do we have in CLARUS consortium (knowledge, network, skills, technology?

Weaknesses:

- What could we improve, and what is difficult?
- What limitations do we have? (e.g., resources, know-how)
- Are there any additional assets we need (technology, skills)?
- What could CLARUS stakeholders see as weaknesses?

For the external categories of Opportunities and Threats, valuable input is already provided by the Competitor Analysis and the PESTLE Analysis. For further inputs below questions were helpful.

Opportunities:

- Which trends are favourable for CLARUS solutions?
- Are there any changes in technology, market, or legislation that we could benefit from?
- What future opportunities are foreseeable?

Threats:

- What are our competitors doing?
- Are there any market trends that could become a threat?
- Is user behaviour changing in a way that could negatively impact our future service?

The below screenshot (Figure 15) shows the outcome of the brainstorming within a WP2 coordination meeting using the online collaboration tool MIRO.

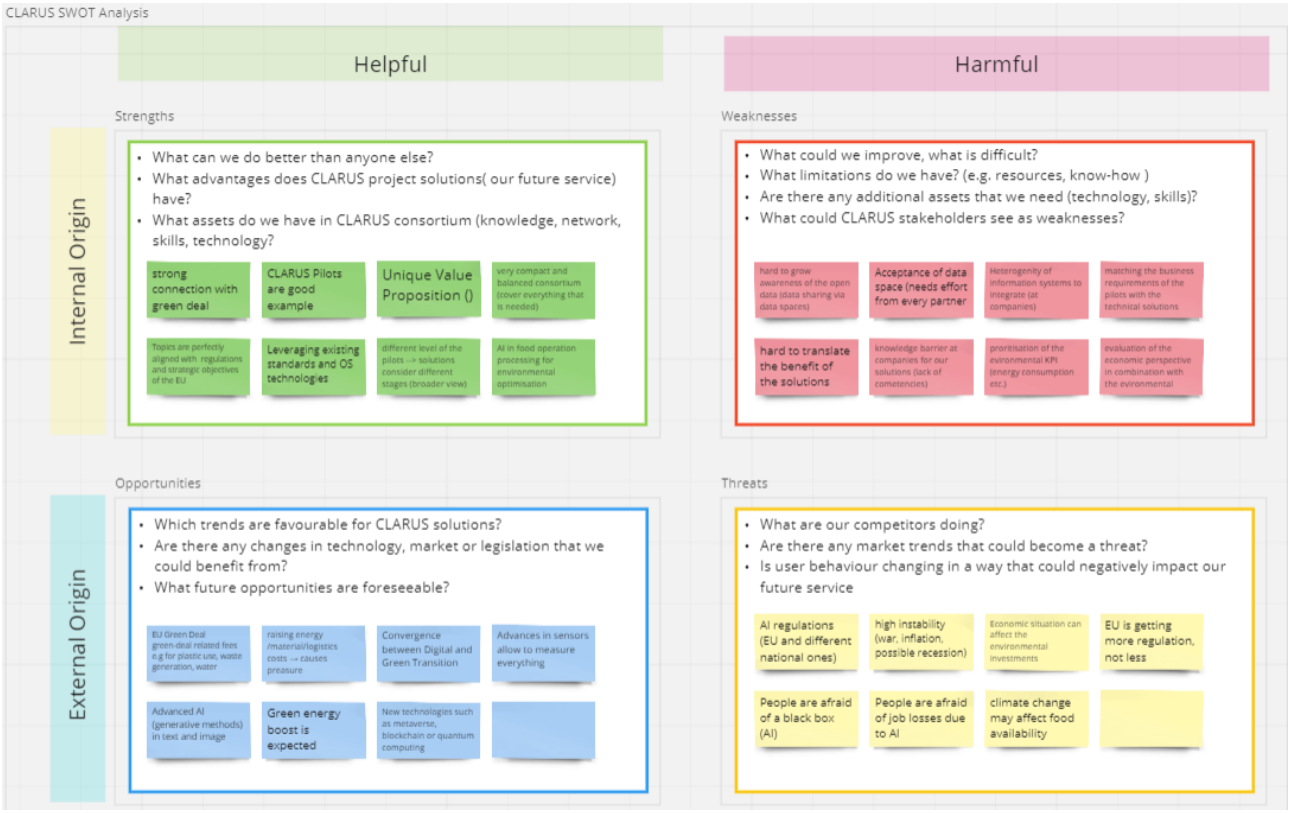

Figure 15: SWOT brainstorming result via MIRO

Table 6 shows the consolidated SWOT analysis results which provide the basis for CLARUS' competitive position and the further strategic alignment.

STRENGTH	**WEAKNESSES**
- Very compact and balanced consortium (highly diverse and skilled team) - Strong connection with EU Green Deal - expected results perfectly aligned with regulations and strategic objectives of the EU - Leveraging existing standards and OS technologies - CLARUS Pilots: different levels consider different stages → broader view - Unique Value Proposition of 3 TEOs: AI in food operation processing for environmental optimisation - Well organised (management, relationship) and experienced - Stable financing for 36 months - Good team spirit - Strong focus on innovation	- Challenge to translate and/or communicate the benefit of the solutions - Tight corset through grant agreement - Lack of previous experience in working together - Creation of acceptance of data spaces (needs effort from every partner) - Heterogeneity of information systems to integrate our solutions at companies - Difficulties of matching the business requirements of the pilots with the technical solutions - Prioritisation of the environmental KPI (energy consumption etc.) - evaluation of the economic perspective in combination with the environmental

OPPORTUNITIES	THREATS
- EU Green Deal: green-deal related fees e.g., for plastic use, waste generation, water consumption - Raising energy /material/logistics costs → causes pressure - Convergence between Digital and Green Transition - Advances in sensors allow to measure everything - Advanced AI (generative methods) in text and image - Green energy boost is expected - New technologies such as metaverse, blockchain or quantum computing	- Fast-moving existing and new competition (agile) - Acceptance of data space (needs effort from every partner) → challenge to create awareness for sharing data via data spaces - Knowledge barrier at companies for our solutions (lack of competencies) - AI regulation mess (national and EU) - Fears related to AI: job losses, black box - High instability due to war, inflation, possible recession etc. - Economic situation can affect environmental investments - Climate change may affect food availability

Table 6: CLARUS SWOT analysis

Subsequently, we would like to highlight the connection between strengths and weaknesses on the one hand and between opportunities and risks on the other. Depending on which characteristics of the project are associated with selected features of the environment, general directions can be derived for strategic planning.

The following questions were used to identify interconnections:

How can we use our strengths to balance our threats and weaknesses?

The threat risk of existing and future competition can be mitigated by our stable financing over the next three years as well as our highly diverse and skilled consortium partners. Furthermore, we can rely on existing state-of-the-art technologies brought in by our partners. We address our weaknesses of being a consortium without previous experience in working together, with an outstanding and carefully monitored project organisation, stringent project management and great team spirit. Our strong focus on innovation helps us to cope with the tight corset of the Grant Agreement. Due to the current EU focus on a standardised data exchange/sharing using Data Spaces (supported also by IDSA) we can cope with the challenges of the acceptance of Data Space solutions.

Which strengths suit which opportunities? How can our strengths be used to best seize our opportunities?

The combination of our three TEOs has the potential to be a unique selling proposition by supporting the EU Green Deal and the convergence between the Digital and Green transition. Through our large and diverse network of partners and the planned cooperation with similar EU projects, we are able to disseminate our work to new user groups and support interdisciplinary research.

Where can weaknesses be turned into opportunities? How can weaknesses be developed into strengths?

Stringent and result-oriented project management and our good team spirit help us to overcome the challenges of working together remotely in a multilingual environment. Our diverse consortium (disciplines, type of partners, gender balance) and the resulting interdisciplinarity is a good prerequisite for the development of innovations. Through the successful implementation of the planned CLARUS solutions, we can demonstrate to companies or create awareness that benefits can be generated with AI and Data Spaces.

The initial SWOT analysis carried out shows first insights on where we are good, what we're lacking, how to minimize risks, and what is needed to take the greatest possible advantage of chances for success. In the further course of the project, we need to update and re-assess these findings regularly and derive the right future strategies.

7. Conclusion & Outlook

Within the present report, we provide the foundation for CLARUS' exploitation and sustainability strategy. By applying a broad mix of methods and tools we got an update on the actual status of the three CLARUS TEOs and on our general exploitation strategy (individual and joint exploitation) as well as insights into existing competition, the business environment, a first strategic orientation, and derived recommendations for the future project work.

The results of a survey conducted among the consortium partners regarding exploitation ambitions (individual and joint) show a balanced mix in the fields of business exploitation and knowledge generation. Most (7 out of 9) of the partners are willing to contribute to CLARUS after the end of the project and have a clear idea of their role to sustain the developed CLARUS solutions. Recommendations for future exploitation activities were derived from the results separated into individual and joint exploitation.

From our conducted (market) environment analysis (PESTLE) we got rich information on each of the six analysed categories. From today's perspective, it is difficult to judge which of the positive or negative factors will have more significance in the future. The many positive ones in the field of technology should not obscure technical trends that can become relevant very quickly. It would be very difficult for CLARUS to pick up on these fast enough. For this reason, the consortium and especially the technical development partners must keep a very close eye on them. Since social factors tend to have a long-term effect, it is unlikely that they will have a rapid effect, either positive or negative. Nevertheless, it is pleasing that the positive factors were found to outweigh the negative.

In order to get a broad overview of the competitive environment 27 GDIs, Data Spaces and AI-Toolkits were identified and evaluated through web-based research. The analysis covers an overview of offered features and functions, organisational insights, strengths & weaknesses as well as impressions on usability and user experience. The analysed examples in the field of GDI, in particular the current publications, show multiple possibilities for how the Green Deal performance can be assessed and which aspects should be taken into account for the CLARUS version. In the Data Spaces area, there is a wide range of learning for CLARUS. We should keep a close eye on relevant EU projects and already existing Data Space and possibly strive for cooperation. In the case of data space component providers, it is reasonable to use the standardised components offered by them. Regarding existing successful data-sharing platform providers, we should look in detail at their UX/UI in order to design a user-friendly and easy-to-use UI for the CLARUS data space. The AI toolkit arena is certainly where the most players are in the game, and thus where the most competition exists. This ranges from similar EU projects to SMEs to very successful large companies. Thus, it is important that we find a promising niche for the CLARUS offering and then fill it with a useful and easy-to-use service. In general, the analysis shows that there are separate market potentials for all three segments of CLARUS TEOs. A unique selling proposition can be created by combining two or all three TEOs, as this has not yet been available on the market.

Finally, the conducted SWOT analysis shows first insights into how we can use our strengths to balance our threats and weaknesses, how to minimize risks, and what is needed to take the most significant possible advantage of chances for success.

Appendix

Competitor Analysis Template:

Solution Description (Green Deal Index, Data Space or AI Toolkit)

Basic description (mandatory information)

Solution Name		**Solution Logo**	
Site URL			
Origin of solution provider/operator?			
Short description of the solution (Aim, Mission, Vision, ect.)			
Overview on Offerings (Services, Products, Features, Functions)			
Focus (regional, geographic, specific research domains or target groups, language versions?)			
Organisation Insights (board, team, legal form etc.)			
Finances (type of revenue streams such as funding, license fee, membership fee, subscription)			

Partners & Stakeholders such as organisations, institutions (public/privat), sponsors etc.

Detailed content description (if available)

Most relevant functions and features Please indicate main functions & features and describe with screenshots and short explanations.
Value adds of solution for stakeholders/users/customers? What feature/function is unique/outstanding? What add-on benefits do the solution offer? How would you describe the solutions's USP (Unique Selling Proposition)?

Usability/UX information (if applicable/available)

What about clarity (understandability) of symbols and wording?
Design of the user interface? clearly arranged, not confusing. Is the interface well organised, logically laid out, easy to navigate – or is it the opposite (cluttered, illogical, complicated)?
Learnings concerning usability/UX for CLARUS What should we transfer to CLARUS, and what should we avoid?

Summary & Conclusions (mandatory information)

Strengths of the solution?	
Weaknesses of the solution? What should we avoid	
Personal rating **(1 = very bad, 10 = best in class)**	
Relevance for consideration within CLARUS What can we learn or should take into consideration for CLARUS Solution	