DIGITAL TECHNOLOGY ASSESSMENT AND DEMONSTRATION TOOLKIT, DRAFT AT M24

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1 Introduction

This report provides documentation of the four tools (applications) that serve the CODECS researchers and other stakeholders to assess technologies and their impacts. The tools are (i) a technology assessment tool for users, (ii) an economic cost calculator, (iii) an environmental footprint calculator, and (iv) a multicriteria assessment tools. Further, the report provides a brief overview of the performance demonstration toolkit that will integrate the assessment outputs and will be developed in Task 7.5.

The target audience of this document is developers and users of the tools; researchers involved in the assessment work, and any other interested persons.

2 Environmental Footprint Calculator (EFC)

2.1 Purpose and Users

The Environmental Footprint Calculator (EFC) is a web-based tool that illustrates the environmental impacts of adopting digital technologies in agricultural production through Life Cycle Analysis (LCA). The tool enables users to assess how changes in production practices, both positive and negative, affect environmental outcomes. By providing a comparative view of agricultural processes before and after digitalisation, the EFC allows for an in-depth understanding of environmental footprints. It supports storytelling by demonstrating the environmental impacts of digital use cases in real-world agricultural settings. It also offers an interactive feature that lets users adjust parameters and visualise how these changes influence environmental outcomes.

Type of Users:

- Farmers and Advisors: To provide practical insights and actionable data to improve agricultural practices
- Education: To serve as an educational resource
- Public Policy Bodies: To inform policymaking with evidence-based insights into the environmental impacts of agricultural digitalisation

Identified requirements:

- Database Structure: Develop a robust database constructed from selected use cases to support comprehensive LCA
- User Interface: Create an intuitive interface where users can input variables relevant to the specific scenario
- Visualisation Support: Implement effective visualisation tools to display the outputs of LCA, helping users identify environmental impact hotspots and understand the implications of digitalisation in agriculture

Tools potential:

The EFC will help farmers and advisors make informed decisions and support educational and policy-making efforts by providing clear and actionable insights into the environmental impacts of digital technologies in agriculture. The EFC has potential uses even beyond the current project. It could be adapted for various agricultural sectors and geographic regions, allowing for broader application in diverse farming environments. The tool can be extended to include additional digital technologies and agricultural practices, making it more versatile for sustainability efforts. Additionally, the EFC can be used in educational settings such as universities and several training programs, providing practical insights for students and professionals. Its data and insights can also inform public policy, supporting environmental impact assessments and sustainability planning at larger scales.

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2.2 Functions

The Environmental Footprint Calculator (EFC) provides essential insights into the environmental impacts of digital technologies in agricultural production by displaying pre-set results for selected use cases from the Living Labs. The basic functions include data collection, which gathers the necessary information for analysis, and Life Cycle Analysis (LCA) calculation, which evaluates and compares the environmental impacts of agricultural practices before and after the adoption of digital technologies. These steps within WP4 (T4.3) enable a thorough understanding of how digitalisation affects environmental outcomes.

The Environmental Footprint Calculator (EFC) includes the following essential functions:

1. General description of Focal Action Situation (FAS):
    - Use Case Title: The specific agricultural scenario being analysed
    - Focal Action Situation - Short Description (Type of agricultural production, digital technology description with details about the digital technology being utilised and the service it provides)
    - Scenario Description:
    - Reference Scenario: Describes the agricultural process without digital technology
    - Digital Scenario: Outlines the process with the digital technology
2. Data Visualisation:
    - Function: Displays the results of the LCA in an intuitive visual format, such as graphs, charts, and impact maps
    - Explanation: Effective visualisations help users easily understand complex data and identify key impact areas, making the information more accessible and actionable
3. Scenario Simulation:
    - Function: Enables users to simulate different scenarios by adjusting input parameters and observing the resulting environmental impacts
    - Explanation: This interactive feature allows users to experiment with various changes in their production practices and instantly see how these adjustments affect their environmental footprint
4. Hotspot Identification:
    - Function: Identifies critical steps in the production process that have significant environmental impacts
    - Explanation: Highlighting these hotspots helps users focus on areas where improvements can have the most substantial environmental benefits

Development process

The EFC's functions have evolved significantly through iterative development and team meetings. The team discussed identified areas for improvement and experimented with different visualisation techniques to enhance user experience.

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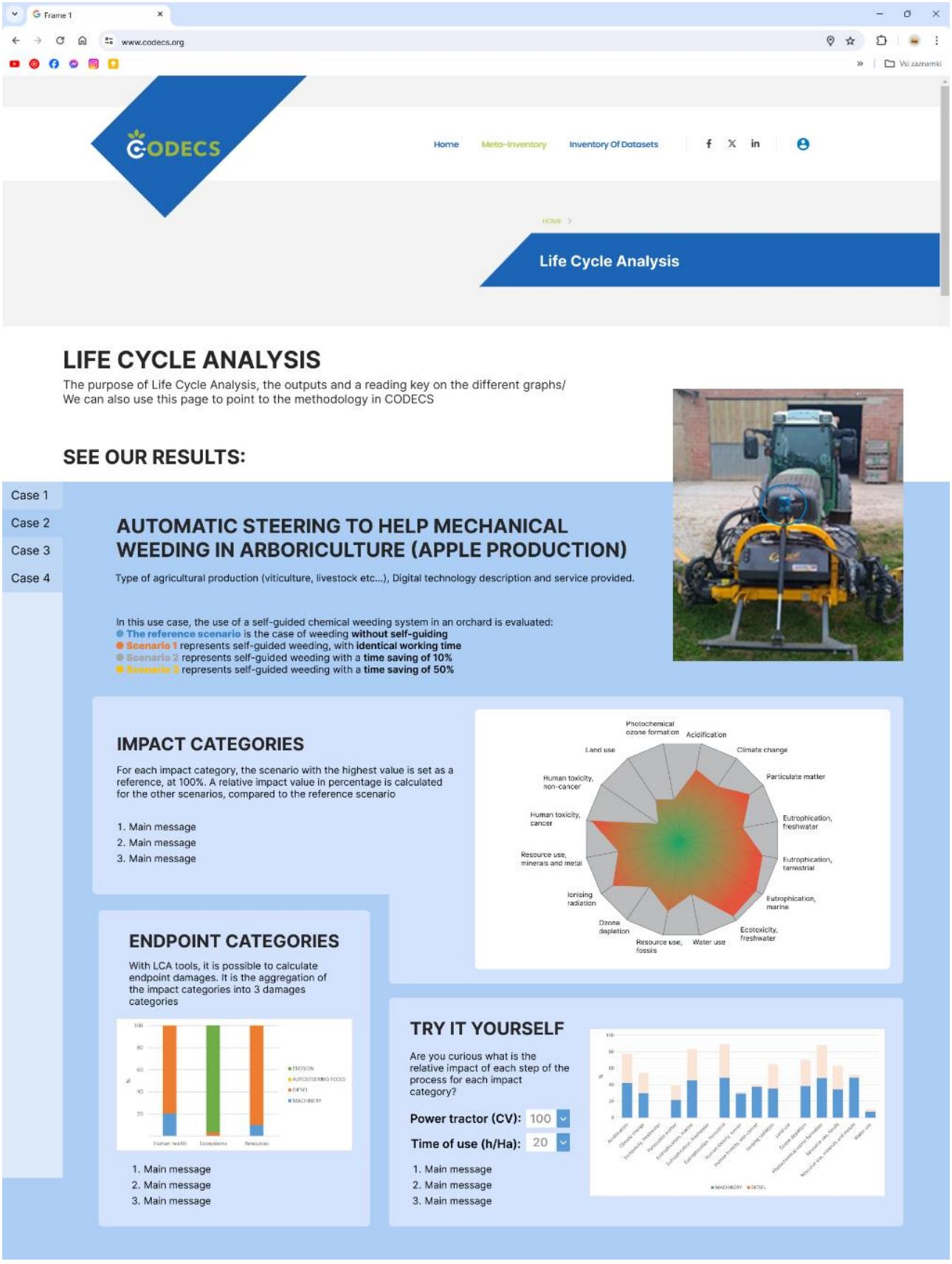

Figure1: mock-up of user interface (latest version), possible visualisation

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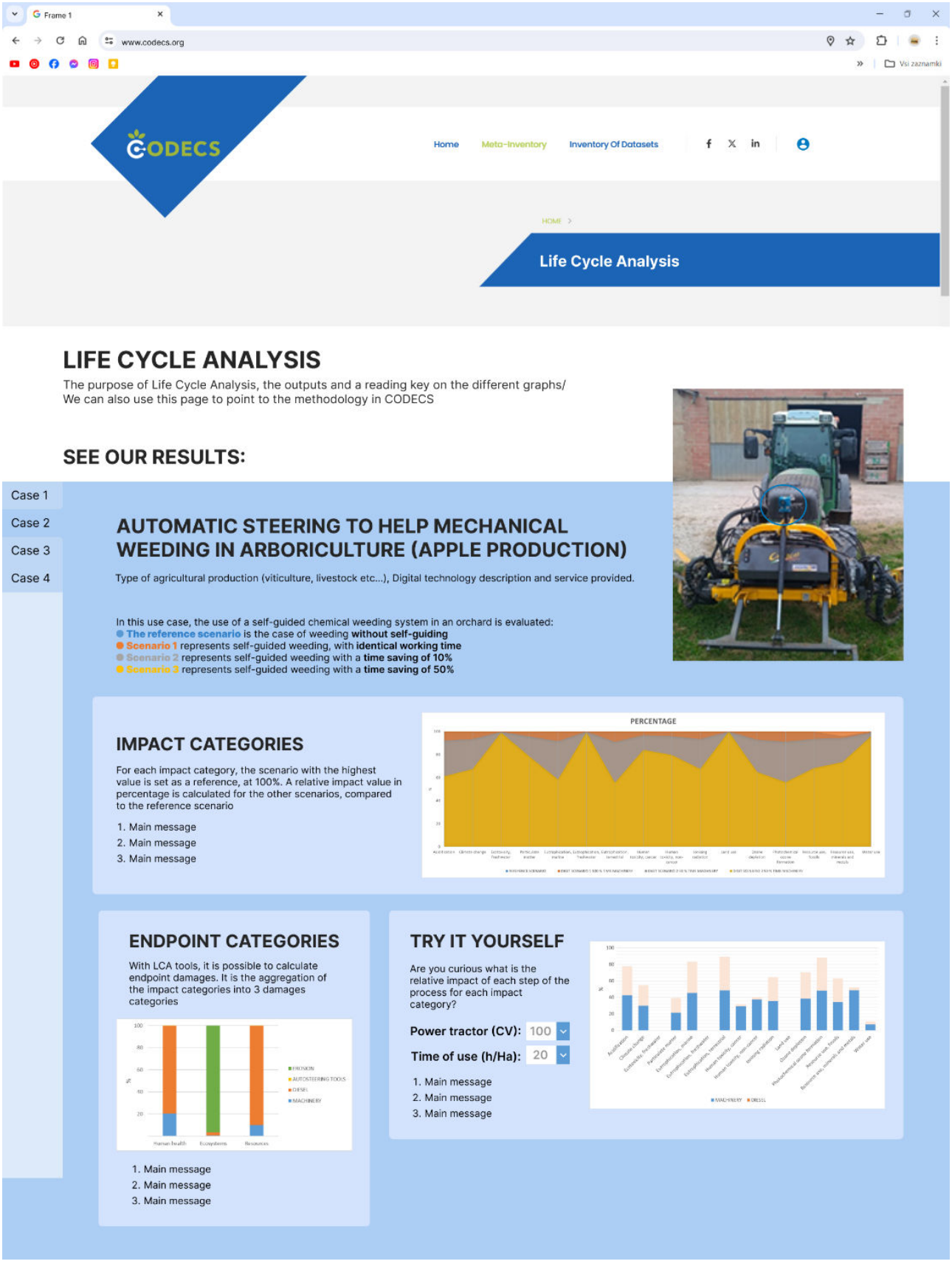

Figure 2: Mock-up of user interface, possible visualisation

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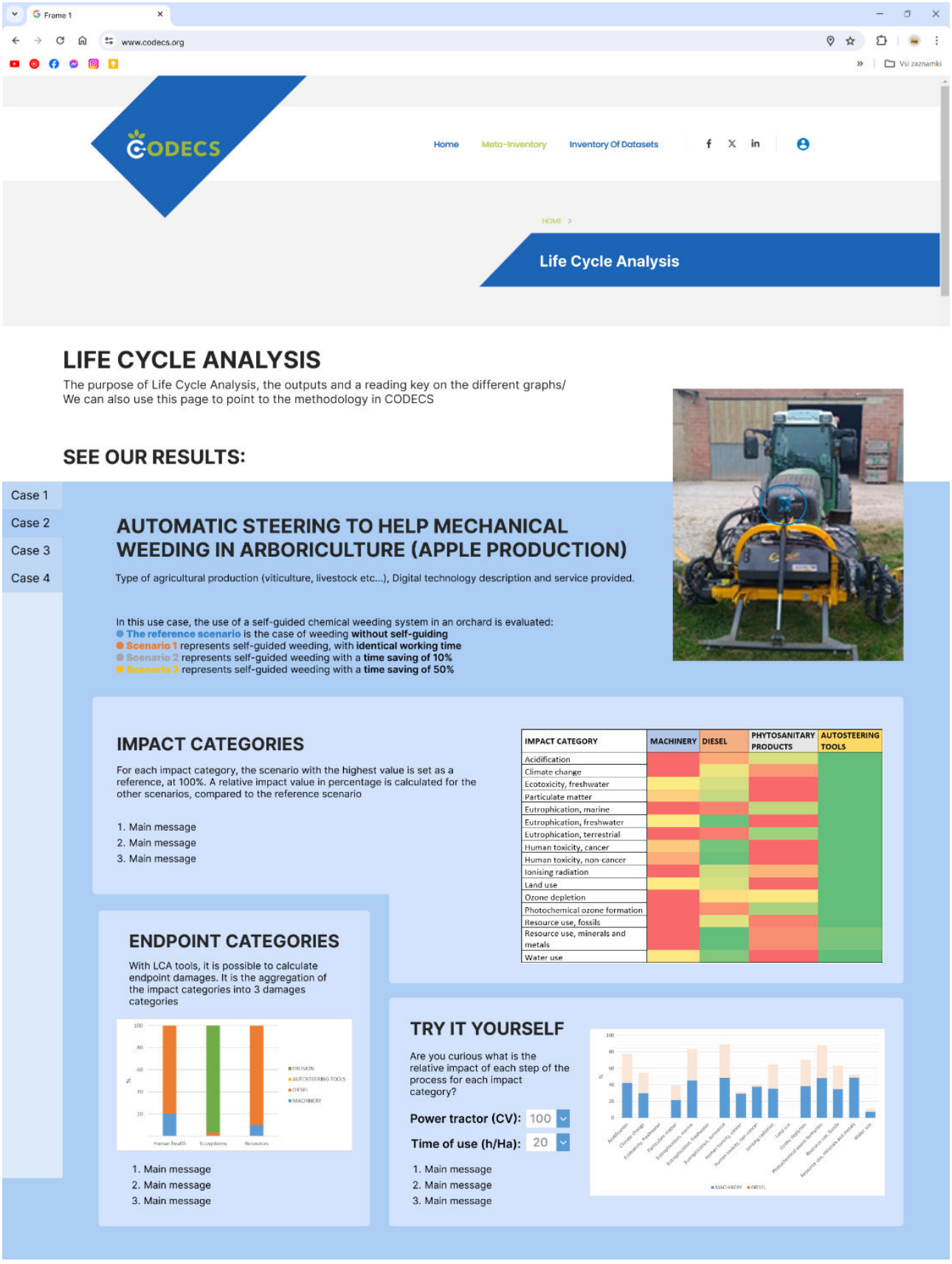

Figure 3: Mock-up of user interface, possible visualisation

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2.3 Data

The Environmental Footprint Calculator (EFC) displays hard-coded results for the chosen use cases (Living Labs). The initial steps are performed within WP4 (T4.3), starting with data collection, which gathers the necessary information for analysis. Following this, Life Cycle Analysis (LCA) Calculation and Comparative Analysis are conducted to evaluate the environmental impacts.

Below is an example table showing the data used for the EFC:

	IMPACT CATEGORY	UNIT	REFERENCE SCENARIO	DIGIT SCENARIO 1 100 % TIME MACHINERY	DIGIT SCENARIO 2 90 % TIME MACHINERY	DIGIT SCENARIO 3 50 % TIME MACHINERY
1	Acidification	mol H+ eq	5,94E-06	5,94E-06	5,48E-06	3,63E-06
2	Climate change	kg CO2 eq	0,000725018	0,000725958	0,00067887	0,000490894
3	Ecotoxicity, freshwater	CTUe	0,14061201	0,14063459	0,14042165	0,13957892
4	Particulate matter	disease inc.	2,19E-11	2,19E-11	2,10E-11	1,72E-11
5	Eutrophication, marine	kg N eq	2,33E-06	2,34E-06	2,14E-06	1,37E-06
6	Eutrophication, freshwater	kg P eq	2,48E-06	2,48E-06	2,47E-06	2,46E-06
7	Eutrophication, terrestrial	mol N eq	2,40E-05	2,40E-05	2,19E-05	1,34E-05
8	Human toxicity, cancer	CTUh	7,57E-13	7,58E-13	7,34E-13	6,38E-13
9	Human toxicity, non-cancer	CTUh	1,54E-11	1,54E-11	1,48E-11	1,23E-11
10	Ionising radiation	kBq U-235 e	6,83E-05	6,84E-05	6,39E-05	4,62E-05
11	Land use	Pt	10,040228	10,040232	10,040138	10,039762
12	Ozone depletion	kg CFC11 eq	1,46E-10	1,46E-10	1,36E-10	9,47E-11
13	Photochemical ozone formation	kg NMVOC e	6,52E-06	6,52E-06	5,95E-06	3,65E-06
14	Resource use, fossils	MJ	0,010891204	0,010903407	0,010212851	0,00745551
15	Resource use, minerals and metals	kg Sb eq	6,91E-09	7,20E-09	6,80E-09	5,30E-09
16	Water use	m3 depriv.	0,000230466	0,000230597	0,000228788	0,000221604

Figure 4: Data behind the visualisation

2.4 Technical specifications

Technical specifications will be documented when the actual development programming starts.

Technical specifications	Data
Developer	Gregor Balkovec, University of Ljubljana
Date of release	End of year 2024
Software version	1.0.0
Expected update	1x/year
Used technology	React (Typescript, MUI). Next.js

3 Economic Cost Calculator (ECC)

3.1 Purpose and Users

The tool is designed to showcase the economic costs and benefits of adopting digital technologies, serving as a decision support system for farmer advisors, policymakers, and farmers. It provides valuable insights into how adopting digital technologies affects economic costs in agriculture, highlighting the investment attractiveness of these technologies. The tool's development includes creating a database based on gathered economic data, designing a user-friendly interface for easy input of variables, and incorporating data visualisation for clear presentation of results. Beyond its agricultural focus, the economic costs calculator has broader applications in

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business planning, academic research, public sector policy analysis, and even personal finance for cost-benefit analysis and investment decisions.friendly interface for easy input of variables, and functions.

The economic costs calculator includes several key functions to assess the financial implications of a project. First, it captures the **duration of the project** in years. Next, it distinguishes between **fixed costs** (one-time investments at the project's start) and **variable costs** (annual recurring expenses). The **savings or benefits section** allows users to input projected savings across different categories. Additionally, the tool includes a **discount rate** field (expressed in percentages) for financial analysis. Finally, the **results section** provides a descriptive interpretation of the outcomes, accompanied by graphical representations to facilitate easy understanding.

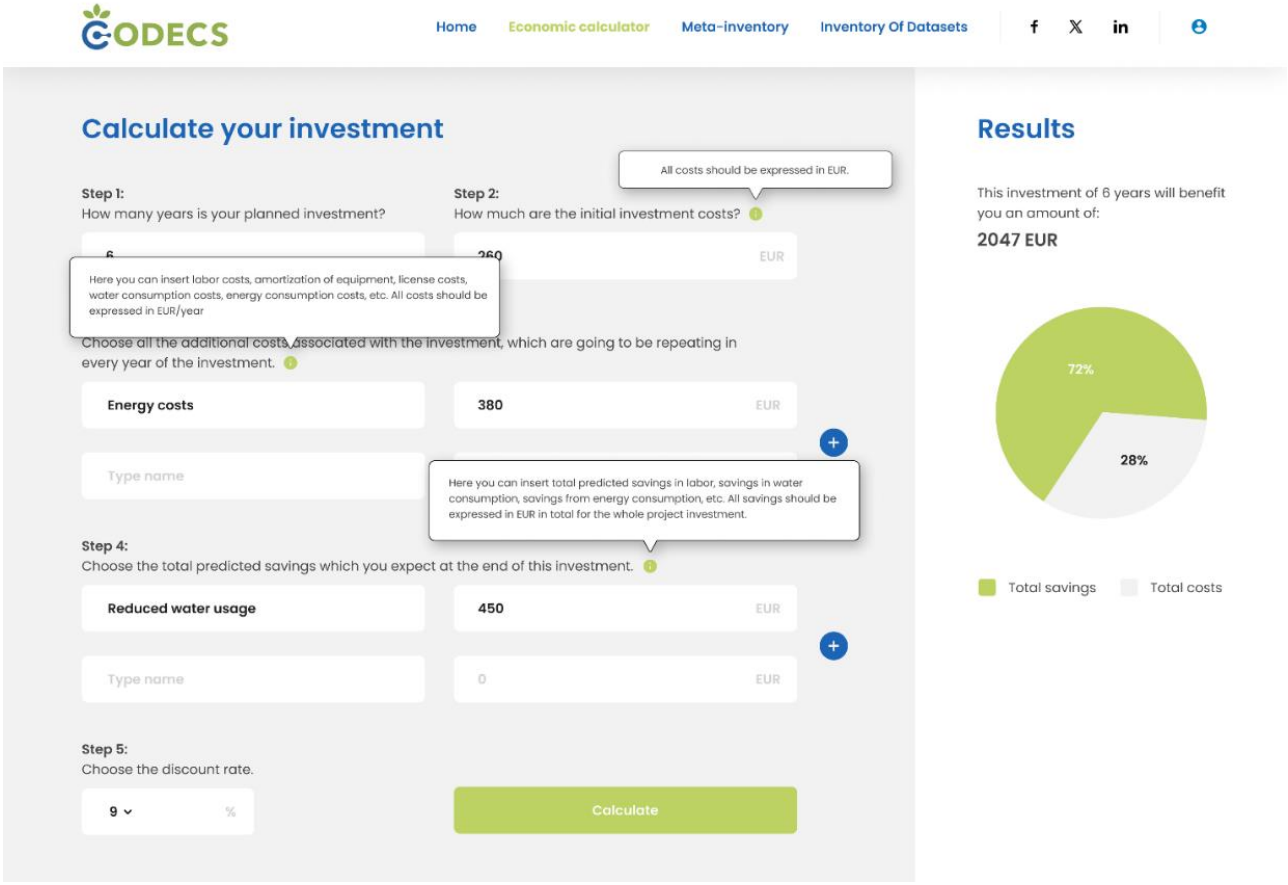

Figure 5: Result section

3.2 Data

The required input data for the tool includes categories such as initial fixed costs, recurring variable costs, predicted savings or benefits, project duration, and discount rates. Users will likely input this data in a structured format, such as numbers or percentages. Data may be uploaded or entered directly into the tool, with potential file size limits for larger datasets. This data will be stored securely, allowing for easy access and retrieval for analysis and decision-making purposes.

3.3 Technical specifications

Technical specifications	Data
Developer	Gregor Balkovec, University of Ljubljana

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Date of release	End of 2024
Software version	1.0.0
Expected update	1x/year
Used technology	React (Typescript, MUI) Next.js

4 Technology Assessment Tool (TAT)

4.1 Purpose and Users

The technology assessment tool is operating at the business process level in CODECS. This is the lowest level of transitioning in CODECS, where system thinking comprises issues of, among others, information flow, materials, technology properties, earnings, sale, and readiness, often concentrated on and around the farm level in a Living Lab setting. There is a need for Living Lab representatives to understand, based on their own priorities, which technology is most relevant to them, from a system thinking perspective. The primary purpose of the tool is to conduct a comprehensive technical assessment of the digital technologies used in Living Labs to determine their effectiveness in meeting the specific needs of users. This assessment involves assigning impact scores provided by experts and weighing these scores against the needs set by the farmers themselves. The tool will provide a structured and objective approach to evaluating the adoption of digital technologies on farms, ensuring that the technologies implemented are genuinely beneficial and tailored to the users' needs. The primary users of this tool are agricultural experts, farmers, and technology providers. The tool provides them with valuable insights into the performance and sustainability of various digital technologies, facilitating future-informed decision-making.

Beyond the immediate scope of the project, this tool holds significant potential for broader applications in the future. It can be adapted and extended to assess digital technologies in other agricultural contexts, for instance, it can be used by extension agencies or as a commercial tool for farmers willing to transform their conventional agriculture practices. Additionally, future exploitation of the tool may include integration with other data sources advanced analytics, and thereby enhancing its functionality and relevance in various subsectors.

The 20 Living Labs will contribute with a list of 4/5 relevant technologies they use in their demonstrations. They will also add to the list of relevant technologies to be used in the future. In this way, a list of 80-100 technologies will be listed and assessed according to a set of criteria. The criteria will be defined by means of designing a so-called value-tree. A value-tree arranges relevant criteria from the more general to the more specific. A generic value-tree will be used as a basis for defining the criteria that will be used for the assessment based on expert judgements of the different technologies in the list.

The criteria in the value-tree will also be used to assign weights, i.e., the relevance of each of them to specific context and individual. In the first phase of the project, the Living Lab coordinators will be asked to fill in a questionnaire to assign weights. CODECS has already collected a lot of information from the Living Labs and this study will rely on the collected information to the highest extent possible. Eventually, by end of project time, also stakeholders in the Living Labs will be asked to fill in the questionnaire as part of the operational final tool. The final tool online will be available to anyone operating at farm level, including farmers, advisors, researchers, and policy makers.

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4.2 Functions

The Technology Assessment Tool (TAT) is meant to assist the farmers with reducing their challenges, increasing useful information to the farmer and/or improving their business performances in terms of profit. The functions include:

1) Identification of relevant technologies to be included in TAT. The 20 Living Labs will be consulted with to identify the relevant technology which will be listed with 80-100 technologies that will be included in the online tool

2) Scoring system assessment. A set of factors, i.e. indicators, will be agreed that creates the basis for the technology scoring system. For each factor an impact score for each technology will be assigned by means of expert judgements. This implies that impact scores are predefined. Different types of scoring system exists and in FAIRSHARE a current scoring system using impact scores in the range from 0 to 4 will ultimately be changed for the CODECS purpose into technology impact scores, as well as needs score, i.e. weights assigned for context-based priority scores filled in by the user

3) Practicality analyses. The development of the technology assessment tool (TAT) is based on existing tools (e.g. FAIRSHARE, SMART-AKIS). The FAIRSHARE project has developed a decent TAT that will be further improved by means of a practicality assessment. The factors used in the FAIRSHARE TAT include factors of Usability, Data Management, Challenge, Knowledge Exchange, and Business, as well as the extent to follow the Principles for Digital Development by encouraging Sharing, Reuse, and Improvement. The practicality analyses will see what properties of this tool is appropriate for the specific purposes of CODECS

4) Factor analyses. Factor judgments will take place to judge relevance to assignments of so-called “Need scores” (i.e., priorities) for the specific purposes of CODECS. The factors, i.e. the indicators to be assessed for each technology, which are used for the assessment when assigning impact scores, will be coupled with a need score (i.e. weight) to inform of context specific relevance of the technology for the individual using the tool. The individuals using the tools, i.e. the user, include farmers, producers, agronomists and advisors. The judgements of which exact factors/indicators to be used in the tool will also be based on a literature review, as well as the FAIRSHARE factors, and with feedback based on Living Lab coordinator judgements

5) Technology data handling assessments. The set of 80-100 technologies will be assessed for their abilities to sufficiently handle data collection, storage, analyses, and sharing. In this assessment, interoperability will be one of several aspects to include in the assessment

6) Technology update analyses. CODECS will create an improved TAT that will satisfy the needs of the project as well as be suitable for adding new technologies and assessment of those technologies from different users outside the project

7) Data quality control. When all technology impact scores have been defined by experts, quality checks will take place by involvements of other experts to critically evaluate, as well as by trials by users of the TAT, including the farmers, producers, agronomists, advisors, etc.

8) Usability assessment is directed to the user of the tool, including the farmers, producers, agronomists, advisors, to get feedback on the extent to which the outputs were helping them in certain ways that they will explain

The 8 main functions of the TAT are listed in **Table 1** available on the next page. The strategy of linking information from the Living Labs to the tool will be done by means of listing the 80-100 technologies in an Excel file, and for each technology provide impact scores by using a given set of factors which still needs to be finalised and agreed. The linking of impact scores and the need scores (weights) will be done by simply multiplying and standardising them. The outcome will be a short list of technologies to be considered by the user of the program.

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Table 1. Main functions of the TAT development

Function	Description	Purpose
1) Identification of relevant technologies	Based on LL contributions, a total of 80-100 relevant technologies will be listed	A selection of a short list of technologies will be provided based on the 80-100 technologies for each user of the tool
2) Scoring system analyses	Make a short list of different impact scores (e.g. 0-4, 0-100%, -3,-2,-1,01,2,3, etc) exist that will be analysed for the purposes of CODECS	Different scoring systems can be used in assessments, and for the purposes of CODECS decisions must be made
3) Practicality analyses	Similar tools, often referred to as multicriteria analyses tool, to TAT are available and will be analysed for the extent of relevance to CODECS	To make sure the existing tools to be built on in CODECS are improved substantially for the purposes of the goals of CODECS
4) Factor analyses	The factors are the criteria/indicators to be used for the TAT, and a selection that is relevant must be assured	To ensure the most relevant indicators are used for the TAT
5) Technology data handling assessment	The selected 80-100 technologies are expected to have different capacities to handling data and will therefor be assessed	CODECS considers the ability to handle data are especially important feature of technology, and this insight is operating as a part of the technology assessment
6) Technology update analyses	The 80-100 technologies listed at first will be reconsidered given the relevance and logics of including it in CODECS	It is important for CODECS to highly ensure relevance in technology options to be assessed given that they are provided as advised options to users in the tool
7) Data quality control	The impact scores of the technologies are judged by experts and it is important that also other experts agree to the impact scores assigned	Given that the impact assessments of the technologies are predefined, it is critically important for the results that the impact scores are agreed by experts
8) Usability assessment	This assessment targets the users of the tool to understand how useful the outcomes of technology advice are	To make sure the tool is fulfilling its purpose of assisting the users of technologies to get needed information for so to increase their business opportunities

4.3 Data

The data required for the tool will be derived from multiple sources: existing data collected in Living Labs, data used in WP3 for process modeling, and data from T7.2 and T7.3. If these sources are insufficient, additional data will be gathered through workshops, particularly to address the factors forming the basis of indicators to be assessed in WP2. The necessary data includes the types of technologies, listed and assessed in Excel sheets, indicators or

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criteria for technology assessments, impact scores assigned by experts for each indicator, and needs scores (weights) set by consortium partners during development and by users when the tool is operational impact scores.

4.4 Technical specification

The software will integrate three existing systems: the FAIRSHARE TAT (Agfitura), the VARI software (WR), and an Excel sheet with multicriteria evaluations (PISA). The FAIRSHARE TAT will provide tools for technology adoption assessments, while VARI software will handle data analytics and process modeling. The Excel component will facilitate multicriteria evaluations, where different technologies and indicators are assessed across various criteria. These systems will work together, allowing data from each to be seamlessly integrated, analysed, and presented to tothe user in a cohesive decision-support platform.

5 Multicriteria Assessment Tool (MAT)

5.1 Purpose and Users

The Sustainability Assessment Tool (SAT) will be developed using Multicriteria Analysis to evaluate technologies at the digital ecosystem level. CODECS defines digital ecosystems as an organised network of digital, socio-economic, organisational, and physical elements that facilitate the production, storage, communication, and utilisation of digital technologies and data. Rather than evaluating individual technologies, this chapter focuses on assessing relevant scenarios for economic, social, and environmental sustainability within the context of a digital ecosystem. Building on the conceptual framework and methodology established by CODECS, particularly the conceptual tree developed for the TAT, we will develop a set of criteria for the SAT. These criteria will be essential for evaluating the sustainability of different scenarios within digital ecosystems. Following the Multicriteria approach, each scenario will integrate a range of alternatives (e.g., traditional irrigation methods, manual smart irrigation, or DSS for irrigation), criteria (such as economic factors like NPV, environmental aspects like water savings, and social factors like the number of jobs created or maintained), and the corresponding evaluations of each alternative against these criteria. Evaluations within the multicriteria matrix can take the form of deterministic values reflecting the uncertainty and complexity inherent the real-world decision-making settings. The criteria will employ a set of indicators that will creates the basis for the sustainability scoring system and reflect our comprehensive approach to the three dimensions of sustainability throughout the entire project. The indicators will be derived from the information gathered in the living labs within CODECS and from the evaluations provided for the TAT. While the SAT involves developing a more complex set of indicators that differentiate it from the TAT analysis, given the distinct level of analysis (digital ecosystem), both methodologies share the same overarching decision-making tree framework. This ensures consistency in the overall framework while allowing for tailored criteria specific to the objectives of each digital ecosystem.

Social Perspective

CODECS evaluates social criteria by considering access, rights, social capital, and control, alongside traditional factors like employment and healthcare. Social impacts are linked to farmer/user readiness and social divide, with risks assessed at multiple levels. A multidisciplinary approach informs farmers about the effects of digital technology on their practices.

Economic Perspective

Economic criteria focus on costs and benefits related to productivity, services, and livelihood across organisational and market levels. Evaluations include product quality, revenue, input, and system costs, with digitalisation analysed through setup, transition, and full operation stages, each requiring investment assessments.

Environmental Perspective

Environmental criteria address interconnected systems like climate and water cycles, evaluating benefits and costs through various environmental values (e.g., nature vs. human benefits, direct vs. indirect impacts). Biophysical assessments gauge potential environmental impacts before applying more value-based approaches.

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The primary users of the SAT are stakeholders involved in the strategic planning and management of digital ecosystems. This includes:

- Digital Ecosystem Managers: Individuals or teams overseeing and optimising the digital infrastructure within an agricultural or environmental context
- Policy Makers and Regulators: Government officials and regulatory bodies who need to assess the sustainability of various digital technologies and practices to inform policy and regulatory decisions
- Researchers and Academics: Those involved in studying the impacts of digital technologies on sustainability across social, economic, and environmental dimensions within broader ecosystems
- Living Lab Coordinators and Participants: Those leading and participating in Living Labs, who require a comprehensive understanding of how different scenarios and technologies impact sustainability at the ecosystem level
- Consultants and Advisors: Experts providing guidance to organizations on the sustainable implementation of digital technologies within digital ecosystems
- Technology Providers and Developers: Companies and innovators developing digital solutions who need to ensure that their products align with sustainability goals and meet the needs of the digital ecosystems in which they are deployed
- NGOs and Advocacy Groups: Organizations focused on promoting sustainable practices within agriculture and digital ecosystems, who may use the tool to advocate for specific technologies or approaches

5.2 Functions

1) The tool begins by collecting data to identify relevant sustainability scenarios from the 20 Living Labs and other relevant sources, focusing on the impact of specific digital technologies and practices. These impacts are then evaluated against the predefined criteria, using a structured approach based on the decision-making tree. The SAT employs a multicriteria analysis framework, where each scenario is assessed for its performance across the different criteria, which will be included in the online tool. The output of the SAT is a sustainability score for each scenario, which provides a comprehensive overview of its potential impacts. This allows stakeholders to compare different scenarios and make informed decisions that align with sustainability goals. The tool is flexible and can be adapted to different contexts within digital ecosystems, ensuring its relevance across various applications.

2) Scoring system assessment

- Pairwise Comparisons and Criteria Weighting: The initial step involves the Analytic Hierarchy Process (AHP), a structured multicriteria decision-making method used to determine the relative importance of various criteria through pairwise comparisons
- Scoring and Ranking: The subsequent steps utilize the TOPSIS method, a widely recognized MCDM technique. TOPSIS estimates the relative closeness of each alternative to an ideal solution, enabling a clear ranking based on how closely each option aligns with the optimal outcome
- Practicality analyses. The development of the SAT is based on consolidated approaches (e.g. AHP, TOPSIS). The practicality analyses will see what properties of are appropriate for the specific purposes of CODECS
- Factor analyses
- The evaluation of factors will be conducted using the Analytic Hierarchy Process (AHP) to determine the relative importance of each criterion, including the indicators assessed for each sustainability scenario

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These factors will then be used to assign impact scores, which will inform the scoring and ranking of sustainability scenarios through the TOPSIS method. TOPSIS ranks alternatives based on their proximity to an ideal solution, with the concept that the best alternative should have the shortest distance from the positive ideal solution (I+) and the greatest distance from the negative ideal solution (I-)

This process can be summarised in three key steps:

- Identify the Positive Ideal Solution (I+) and Negative Ideal Solution (I-): Establish the best and worst possible values for each criterion
- Compute the Relative Closeness to Those Solutions: Determine the relative closeness of each alternative to the ideal and negative solutions, typically expressed as a ratio
- Rank the Alternatives: Order the alternatives based on their relative closeness to the ideal solution

The selection of specific factors and indicators for use in the tool will be informed by a thorough literature review and feedback from Living Lab coordinators, ensuring that the tool remains comprehensive and contextually relevant for its users, including citizens and policymakers.

- Technology data handling assessments. The goal is to select at least 10 relevant sustainability scenarios from across all the Living Labs. These scenarios will then be assessed for their ability to contribute to social, economic, and environmental sustainability
- Sustainability scenario update analyses. CODECS will continuously create an improved SAT that will satisfy the needs of the project as well as be suitable for adding new sustainability scenarios
- Data quality control. When all sustainability scenario impact scores have been defined by experts, quality checks will take place by involvement of other experts to critically evaluate, as well as by trials by users of the SAT, including the citizens and policymakers, etc.
- Usability assessment is directed to the user of the tool, including the citizens and policymakers, to get feedback on the extent to which the outputs were helping them in certain ways they will explain

The 8 main functions of the SAT are listed in table 2. The strategy of linking information from the literature and the Living Labs to the tool will be done by selecting the 10 sustainability scenarios in an Excel file, and for each scenario, provide impact scores by using a given set of criteria that will be further defined and shared. The outcome will be a set of sustainability scenarios for the specific digital ecosystem and related user needs.

Table 2. Main functions of the SAT development

Function	Description	Purpose
1) Scenario development	Based on LL contributions, a total of 10 relevant sustainability scenarios will be developed. For this set of alternatives, a set of Economic, Social and Environmental criteria will be defined	Based on the technologies evaluated in the TAT and the data collected from the Living Labs, digital ecosystems will be defined, and the most suitable scenarios will be developed and selected to meet the objectives of the various stakeholders. From these, the weighting and ranking of the alternative scenario will follow

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Function	Description	Purpose
2) Scoring system analyses	Based on the TOPSIS method from the set of ranked alternatives according to the different criteria, an ideal positive and negative solution will be identified, then alternative will be ranked according to their relative closeness to the ideal solution	Identify and normalise the criteria, then assign weights using methods like AHP. Multiply the normalised values by these weights to create the weighted decision matrix. Determine the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS) and calculate the Euclidean distance of each alternative from both. Assess the relative closeness of each alternative to the PIS, expressed as a ratio. Finally, rank the alternatives based on their closeness to the PIS, with the highest closeness coefficient indicating the best option (final ranking)
3) Practicality analyses	Similar tools, often referred to as multicriteria analyses tool, to SAT are available and will be analysed for the extent of relevance to CODECS	To make sure the existing tools to be built on in CODECS are improved substantially for the purposes of the goals of CODECS
4) Factor analyses	The factors are the criteria to be used for the SAT, and a selection that is relevant must be assured	To ensure the most relevant indicators are used for the SAT
5) Technology data handling assessment	The selected 10 relevant sustainability scenarios are expected to have different capacities to handling data and will therefore be assessed	CODECS considers the ability to handle data as an especially important feature of technology, and this insight is operating as a part of the technology assessment
6) Technology update analyses	The 10 sustainability scenarios listed at first will be reconsidered given the relevance and logic of including it in CODECS	It is important for CODECS to highly ensure relevance in technology options to be assessed given that they are provided as advised options to users in the tool
7) Data quality control	The impact scores of the technologies are judged by experts and it is important that also other experts agree to the impact scores assigned	Given that the impact assessments of the technologies are predefined, it is critically important for the results that the impact scores are agreed upon by experts
8) Usability assessment	This assessment targets the users of the tool to understand how useful the outcomes of technology advice are	To make sure the tool is fulfilling its purpose of assisting the users of technologies to get needed information so as to increase their business opportunities

5.3 Data

The data for the tool will be sourced from various key areas, including data already collected in the Living Labs, data from WP3 for process modeling and WP4 for cost-benefit analysis, and additional data from T7.2 and T7.3. If further data is required, it will be gathered from workshops, where different scenarios and sets of Economic, Social, and Environmental criteria will be discussed annually. The required data includes types of technologies already identified for the TAT and a set of criteria defined with project partners and LL coordinators. These criteria will cover aspects

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like expected Net Present Value (NPV), government costs, environmental impact (e.g., water savings, erosion impact), job creation, and overall acceptance, enabling a comprehensive sustainability evaluation of different technologies across scenarios.defined.

5.4 Technical specifications

The technical specifications are similar to section 4.4. The weights estimated by VARI can be done by using the software called VARI. This can be combined with the CODECS online tool if appropriate. The combination of weights and impact scores can be done using the the tool developed in the frame of Task 4.6.

5.5 What are Interactive Storybooks?

Interactive storybooks represent a fusion of the verbal and visual elements characteristic of traditional storybooks with the capabilities inherent to multimedia technology. These storybooks are designed to engage readers through interaction, such as clicking on characters or objects that trigger animations, sounds, and additional narrative elements. Interactive storybooks integrate audio narration, background music options, videos, puzzles, and games, enhancing the reading experience and making the content more interactive and educational.

These storybooks are designed to enhance engagement through various forms of interaction. By including features such as clickable objects, animations, and sound effects, readers can explore the story in a more immersive way. In addition to interactive elements, these storybooks often include multimedia components like audio narration, background music, videos, puzzles, and educational games. They also provide ways to extract feedback from the reader, enhancing the experience and usability not only for the reader but also for the writer.

5.5.1 Scope in terms of CODECS Project

Regarding the CODECS project, and in completing Task 7.5 ‘Sustainability Performance demonstration toolkit’, it is anticipated that the project will deliver interactive storybooks, which will provide the results of the tests and experience feedback by digital technology users. This will be based on input from the outcomes of the Meta-Inventory of Digital Technologies and the on-farm demonstration activities. The content will combine audio-visual material from the Living Labs (LLs) with textual information from AUA. These storybooks will be integrated into the CODECS digital platform.

The rationale for creating Interactive Storybooks is rooted in the unique value of these dynamic, living documents and how this value aligns with the project's post-dissemination goals for the technologies. More concretely, Interactive Storybooks as a means of dissemination and reporting provide:

- Enhanced visibility: Visual engaging and interactive material is an effective way of demonstrating complex ideas intuitively, making sure that the user will follow through with the whole idea
- Impact assessment: By presenting the project's outcomes and impact, a flipbook can help assess the effectiveness of the project's activities and strategies
- Long-term Documentation: Flipbooks can serve as a permanent record of the project's progress, ensuring that the achievements and lessons learned are preserved for future reference and to support future projects
- Enhanced accessibility: A Storybook with visual cues is a more effective medium and can be disseminated easily online, ensuring resonance with a broader audience

It thus appears that LL activities are particularly relevant. Furthermore, it is essential to establish connections with the DECO activities of CODECS. The potential impact of the interactive storybook(s) at the dissemination, exploitation, communication, and outreach levels is significant.

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5.5.2 Selection of flipbook maker

An internal process was undertaken with the objective of selecting the optimal tool for use by flipbook makers. To this end, a research and comparative analysis was conducted in order to identify the most appropriate flipbook maker for the project and to ascertain the appropriate scope of the task.

A review was carried out of the various available flipbook makers, with particular attention paid to the following criteria: the available features, the level of interactivity, the types that can be uploaded (e.g. images, texts, videos, etc.), the pricing, and hosting. Subsequently, a decision was made to utilise Heyzine as an advanced digital flipbook creator, with the objective of enhancing the interactivity and accessibility of the project's storybooks. This will facilitate the creation of visually engaging and interactive storybooks that combine textual information with rich audio-visual content sourced from Living Labs (LLs), as illustrated in examples provided in Figures 6 & 7 below.

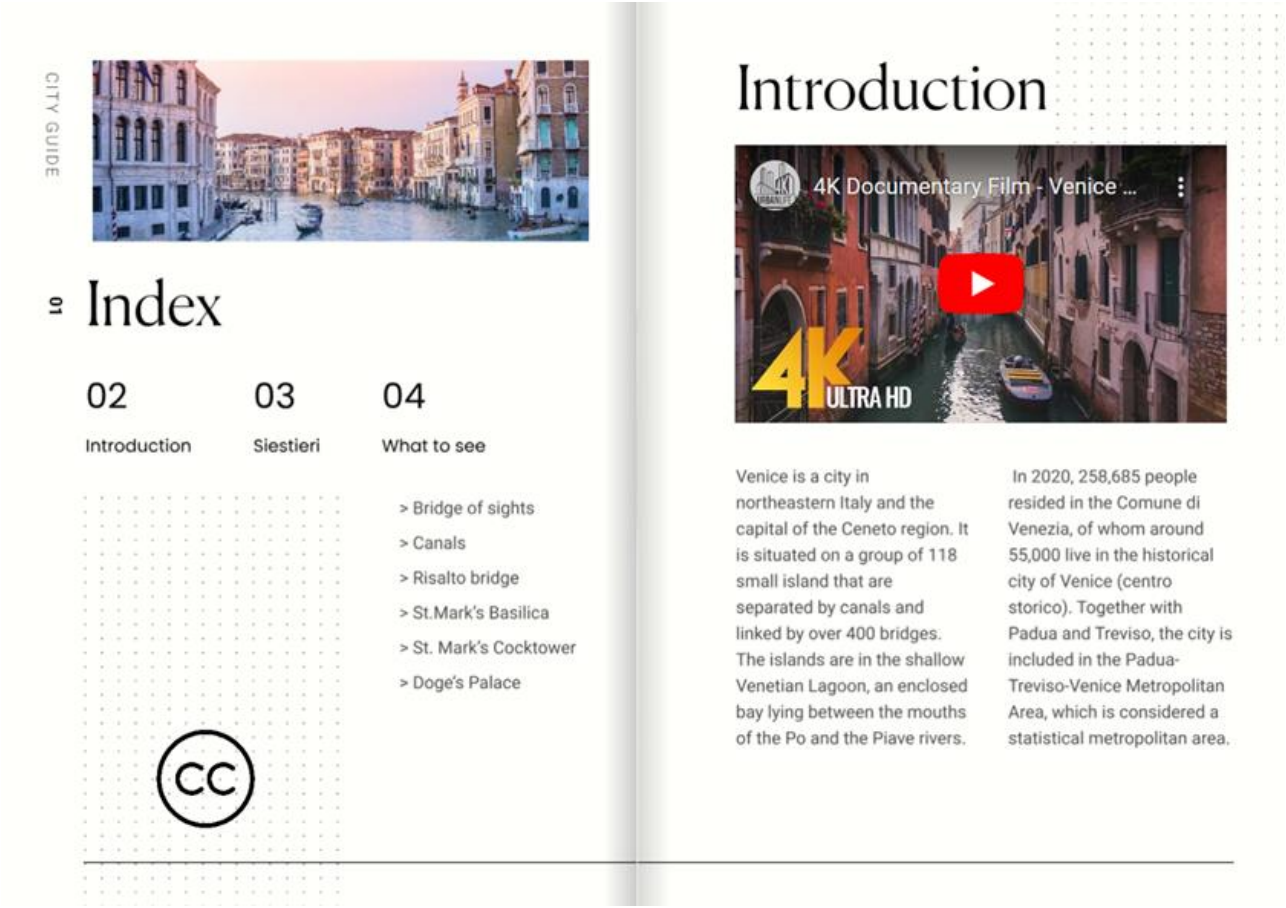

Figure 6: Storybook slides incorporating an index and video with textual explanations, providing an overview of the area.

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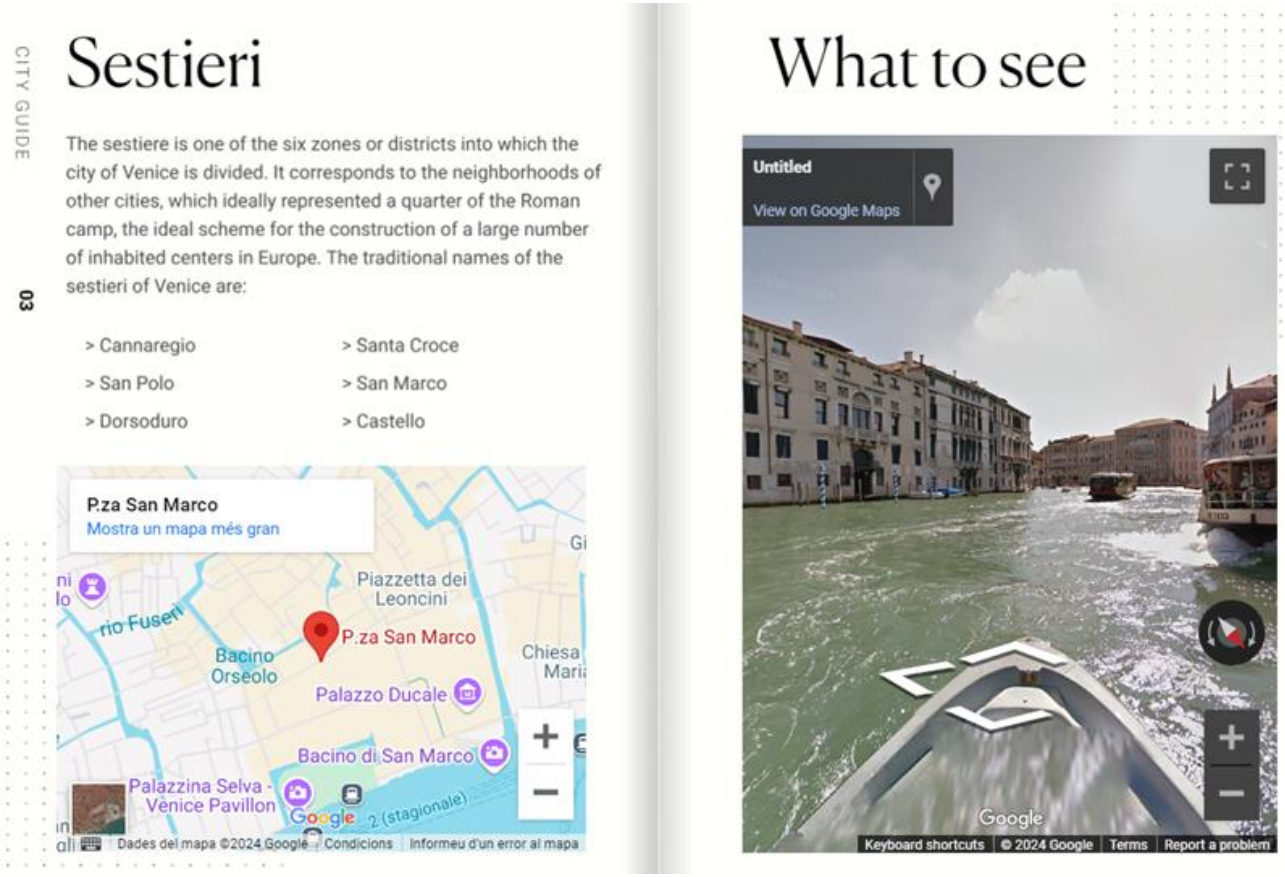

Figure 7: Storybook slides with the integration of Google Maps, highlighting a pinned location and offering navigation insights.

The key criteria for the selection of this tool were:

- **Interactivity features**: this tool offers a wide range of interactive features including embedding videos, images, links and customisable hotspots, making it a versatile tool for creating engaging storybooks. This capability is crucial for showcasing the innovative tools and technologies being demonstrated in the CODECS project.
- **User-friendly interface**: The platform offers a straightforward drag-and-drop interface, making it easy for contributors to design and update storybooks without extensive technical knowledge.
- **Cost-effectiveness:** the selected tool stands out as a cost-effective option with competitive pricing for its range of features.
- **Platform integration:** Heyzine integrates seamlessly with digital platforms, making it suitable for embedding storybooks into the CODECS project platform.
- **Cross-device accessibility:** Heyzine storybooks are optimised for viewing across various devices, ensuring that stakeholders can access and engage with the content seamlessly on desktops, tablets, and smartphones.
- **Customisation:** Heyzine allows for customisable designs and branding, which is essential for aligning the storybooks with CODECS project goals.

5.5.3 Internal Process for collaboration and input

Regarding the completion of Task 7.5, internal meetings were arranged during the procedure required to be undertaken. It was agreed that the research outcomes of the LLs should be the focal point of the agenda and the primary aspect to be communicated through the interactive storybooks. Therefore, interactive storybooks will

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function as dynamic documents, with the content being continuously updated to reflect progress made within each LLs.

The content of the Interactive Storybooks was collaboratively determined to reflect the perspectives and activities of all LLs and to align with the project's initiatives and objectives. To compile the necessary data for each LL's storybook, the respective task or/ and WorkPackage leaders responsible for each section will be actively involved, and a verification will be asked for by the LL Coordinators. The following are the main sections that will be included:

- Co-development of conceptual framework
- Mapping the socio ecological context
- Farm Socio-technical Process Modelling of Use Cases
- Analysis of Costs and Benefits (C&B) perception
- Analysis of Environmental Costs of the use of digital technologies at farm level
- Analysis of Economic C&B
- Analysis of Social Costs and Benefits
- Multi-criteria assessment of Costs and Benefits
- Demo Farm Network
- Conducting on-farm demonstration activities
- Conducting Virtual Demonstration activities
- Policy foresight exercise
- Digital technology assessment toolkit (technology assessment toolkit for users)

5.5.4 Timeline for the implementation and delivery of the storybooks

It is agreed that, until the delivery of the final version of the storybook, a preliminary version will be presented to the Consortium at the General Assembly meeting scheduled for December 2024. This will ensure that all members of the Consortium are informed of the final version. Subsequently, it is anticipated that the storybooks will be finalised by Spring 2025. Given the ongoing nature of the project, it is anticipated that one or two revised versions will be produced, as further information is incorporated into the sections over time until the project's conclusion.

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