Product Passport through Twinning of Circular Value Chains

Deliverable 3.5

Plooto Balanced Scorecard v1

WP3: CRIS Integration and Deployment

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Executive Summary

The path towards a green and digital future is full of challenges. The bi-directional reinforcement between green and digital transitions can significantly contribute to address those challenges, capitalising on existing digital technologies to improve activities and achieve goals, such as the use of blockchain technology in material tracing, thus facilitating the circularity within an industrial supply chain.

Under this scope, the Plooto project aspires to support manufacturers in their green, digital and circular transition, capturing end-to-end traceability across industrial value chains and delivering digital tools and services that will enable waste reduction and accelerate reusability of otherwise-waste. The Sustainability Balanced Scorecards (SBSC), is one of the Plooto digital services that will focus on assessing the impact of decision-making at Digital Twin (DT) level, following a robust framework that will enable sustainability and circularity.

This document describes the design and structure of the Sustainability Balanced Scorecard, aligning of the Sustainability Framework defined within the WP1. It follows dedicated implementation steps, and takes into consideration the needs and perceptions of each pilot use case within Plooto. The SBSCs are designed as a one-stop-shop tool for circularity and sustainability, building on the services and tools delivered within WP2. More specifically, the Process Simulation and Modelling service, developed and provided by TUC team, is being expanded and updated, to integrate the SBSC service, as a module. The selected KPIs per use case are exploited to define a cause-and-effect model that is expected be the cornerstone of the SBSC service.

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Acronyms and Abbreviations

Acronym	Description
BT	Biological Treatment
CFRP	Carbon Fiber Reinforced Polymer
CPW	Citrus Peel Waste
CPWW	Citrus Peel Wastewater
CRIS	Circular and Resilient Information System
CRM	Critical Raw Material
DPP	Digital Product Passport
DT	Digital Twin
EU	European Union
KPI	Key Performance Indicator
PSM	Process Modelling and Simulation
SBSC	Sustainability Balanced Scorecard
WEEE	Waste from Electrical and Electronic Equipment
WP	Work Package

1 Introduction

1.1 Purpose and Scope

This document is the first version of the deliverable of Task 3.3 Balanced Scorecard and Sustainability Assessment Service, which is related to the design and delivery of a one-stop-shop tool that will assess the circularity level of an industrial value chain and provide recommendations for effective traceability strategies and sustainability and circularity enhancement. Task 3.3 aims to design and implement a dedicated tool for circularity and traceability assessment, taking into consideration the digital tools developed within WP2, structuring the dashboards for Plooto services, including the Sustainability Balanced Scorecard (SBSC). These configurable visualisations aim to support monitoring and decision-making across the value chain, considering aw well lifecycle assessments about the products, incorporating selected Key Performance Indicators (KPIs), to assess the overall product performance, considering the circular economy aspects as well. The SBSC will be integrated into the Circular and Resilient Information System (CRIS) and will have a direct interconnection with another Plooto principal outcome, the Digital Product Passport (DPP). The first version of the SBSC, which is presented in D3.5, will be updated and delivered in M30, under the D3.6, which will include the implementation of the SBSC service to all three use cases, and the final version of the SBSC.

1.2 Relation with other deliverables

Task 3.3 is performed in alignment with the activities of other Work Packages of the project due to its inherent nature and actual functionalities. The main interactions and exchanges among the currently ongoing WPs are noticed under the WP1, WP2, WP3 and WP4, as described below.

- **Connection with WP1:** The activities that take place under the WP1 are intended to identify, design and structure the Plooto circular value chain framework. Task 3.3 is directly interconnected with the outcomes of Task 1.2 Reference Processes and Digital Traceability Strategies and Task 1.4 Governance Models and Sustainability Framework, obtaining critical information about the first version of the Sustainability Balanced Scorecard Framework (D1.3), its architecture and the selected KPIs to serve its scope. Moreover, Task 1.1 is linked with Task 3.3 since the activities of this task were included the initial definition of KPIs and the process flows within the value chains of Plooto use cases.
- **Connection with WP2:** The activities of WP2 are focused on creating the digital representations of the pilots' supply chains, including waste supply chain data spaces, the governance services, the analytics and AI services, optimisation, and process modelling and simulation. Task 3.3 is responsible for creating the visualisations/dashboards of the WP2 services. Moreover, the SBSC structure takes into consideration the overall process, exploiting information and data related to the technical services, connected directly with the Process and Modelling Simulation activities, as presented in Section 0.
- **Connection with WP3:** The activities that deployed under WP3 are related to the integration the CRIS platform and the deployment of the Digital Product Passport. The SBSC, as part of

the Plooto integrated services, will seamlessly connect to both technical and operational, with the CRIS platform and the DPP. The circularity and sustainability assessment of the value chain, as derived by the using of SBSC, will be part of the CRIS platform, and accompanied by the other configurated services, will compose the Plooto holistic solution for enabling the waste reduction, advancing circularity and create end-to-end traceability of secondary raw materials, reusing and/or recycling processes.

- **Connection with WP4:** This work package includes the activities connected to the industrial demonstrations of Plooto project, incorporating the pilots' operation and evaluation actions. Since SBSC is a tailored tool, capable to be applied to each value chain (see Sections 2 & 3), the active involvement of the pilot partners was mandatory for indicating the industry's main goals and objectives, and for defining the specific KPIs that will depict the industrial performance of each value chain.

1.3 Structure of the document

The document is structured as follows:

- **Section 2** introduces the Plooto Balanced Scorecard structural approach, by defining the implementation steps and describing the overall architecture of the tool.
- **Section 3** outlines the adaptation of the scorecard of each Plooto use case, structuring a tailor-made tool, capable of being replicated by each industry. In this section, the connection of the PSM Service and Tool is presented and is described the requirements of each pilot that have been introduced intro the Scorecard.
- **Section 4** is the User Documentation, which targets to help the users understand how to use the scorecard and which are the critical steps.
- **Section 5** presents the mock-ups created for the visualisation part of the scorecard, and the virtual depiction of the scorecard's results and their showcasing in the CRIS Platform.

2 The Balanced Scorecard: Implementation Steps and Architecture

2.1 Designing an integrated one-stop-shop tool

Investigating 12 companies for over a year, Kaplan and Norton introduced in 1992 a set of measures to drive and evaluate the performance of industries and companies [1]. The Balanced Scorecards responds to the willingness of industrial managers and academic researchers to create a balanced presentation of financial and operational measures, that can provide a holistic view of the business, facilitate decision-making and unlock potential opportunities for growth and improvement [1] [2]. This initial version of Balanced Scorecards, was focused on complementing financial measures with goals on customer satisfaction, the internal processes and the industry's manpower [3]. Therefore, the initial tool was dedicated to monitoring 4 specific perspectives as indicated in Figure 1 [1]:

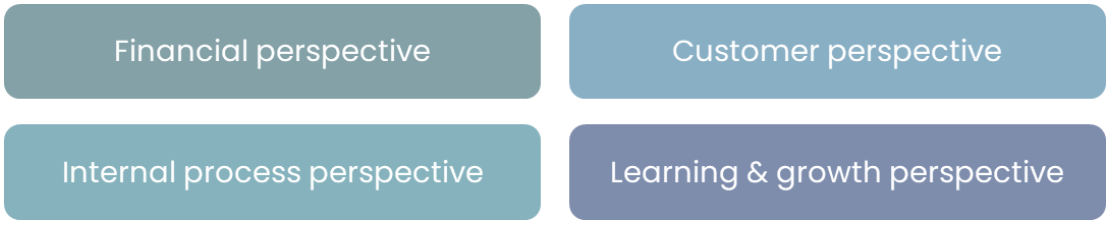

Figure 1: Initial Balanced Scorecard perspectives by Kaplan and Norton

The financial perspective focuses on traditional financial measures such as revenue growth, return on investment (ROI), profitability, investment. The customer perspective represents the customer satisfaction, loyalty, market share, new customers acquisition, customers retention, and other. The perspective of Internal Business Process focuses on the internal processes of an industry/company that are critical in order to achieve the two previous objectives: the financial and the customers. Lastly, the fourth perspective of learning and growth, refers to the organisations ability to learn and innovate. Measures such as the employee satisfaction, the training and development of employees, the motivation, the well-being, are included amongst this perspective [1].

The evolved version of Balanced Scorecards, aimed to facilitate companies to comply with national and local regulations, especially the environmental ones. The sustainability was the critical element of the updated Scorecard, since it enclosed components such as the environment, safety and health issues and regulations, employment practices and community investment [3]. The term *sustainability* was embraced by the authors of articles and scientists that were seeking to elevate the Balanced Scorecard from a simple managerial tool, to a more comprehensive approach that could facilitate the industries and companies to a more sustainable and environmental-friendly profile. Eccles and Serafeim explored the sustainability and financial performance and underlined the importance of a new performance measurement tool that will consider both environmental and social factors [4]. Figge et al, proposed several different approaches for integrating sustainability into the scorecards [2], while Shartegger and Wagner investigated the sustainability as a fifth, individual perspective, alongside with the four traditional ones, developing therefore, the first

comprehensive model of the SBSC[5]. After this work, several new approaches were investigated such as the one of Moller and Schaltegge [6], which expanded the balanced scorecard framework and investigated it as a framework of eco-efficiency analysis, and more recent research on the utilisation of the SBSC for humanitarian organisations [7], and in several industrial applications [8] [9] [10] [11] [12].

Getting inspired and capitalising on the existing literature, Plooto foresees to transform the Balanced Scorecards from a managerial tool that facilitates industries to plan and strategies activities, to configurable one-stop-shop tool that will assess circularity and facilitate tracing strategies. To do so, it builds on the philosophy of balanced scorecards and the main components, incorporating the Sustainability and Governance Framework of Plooto project (see D1.3), for setting up a compact tool, capable of being tailored to each interested company, industry or customer, that is willing to assess the performance of its value chain.

The approach includes the design of the dedicated implementation steps of the Plooto Balanced Scorecard (Section 2.2), the overall architecture (Section 2.3), and how this tool is developed and operated through the Process and Modelling Simulation Tool (PSM), established by TUC, in order to take into consideration the overall value chain virtual representation, and builds on a reliable model, a real virtual representation of the value chain.

2.2 The Plooto Balanced Scorecard Implementation Steps

The Plooto Balanced Scorecard embraces the project's outcomes across multiple tasks. It builds on the Sustainability and Governance Framework derived from WP1, capitalising on the analysis of the various frameworks for sustainability and circularity, and taking into consideration the governance principles, as presented in D1.3 (Task 1.4).

Moreover, the thorough research on detecting dedicated KPIs serves as a pathway for the design of the Plooto SBSC structure, in accordance with the objectives derived from the traceability strategies for each Plooto use case (Task 1.2). This inclusive pathway provides the opportunity for delivering a comprehensive tool, suitable and adaptable at each Plooto use case, having a replicability potential for further exploitation in various industrial value chains.

The implementation is comprised of nine (9) specific steps: ***Assessment, Strategy Definition, Objectives Definition, Strategic Mapping, Targets/KPIs Definition, Strategic Processes, Data Collection and Integration, Cause-and-effect pattern,*** *and* ***Performance Analysis*** (Figure 2).

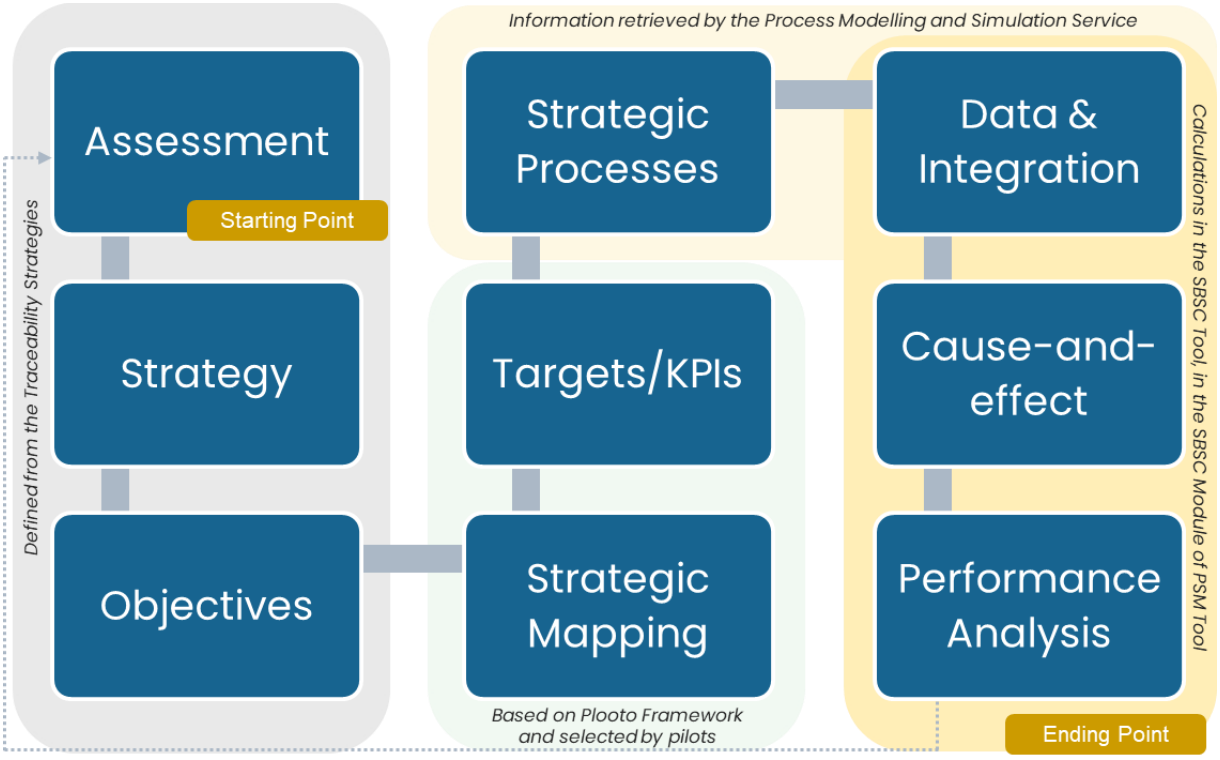

Figure 2: Plooto Sustainability Balanced Scorecards Generic Architecture

- **Assessment & Evaluation**

The starting point of the SBSC structure is the assessment of the current situation, including the potentially existing traceability strategies of the investigated industry/value chain. The operational plans and conditions across the value chain are being detected, while the close collaboration with the industry's stakeholders (in Plooto case the pilot partners) is necessary for capturing potential existing practices on empowering sustainability and circularity within the industry. This first step provides an overview of the current industry/value chain situation, facilitating a smooth transition to the next step: strategy definition

In Plooto SBSC, this step has been defined utilising the outcomes of the Tasks 1.1 (D1.1) and 1.2 (D1.3).

- **Strategy Definition**

This step focuses on the creation of a roadmap to transform the industrial value chain into a sustainable and resilient ecosystem. Under the scope of Plooto project, the mission is clear: to support manufacturers in their green, digital and circular transition, incorporating critical aspects such as the waste reduction and end-to-end traceability. To this end, the strategy definition is common in Plooto for all three pilots, focusing on transforming the value chains into circular value chains.

In Plooto SBSC, this step is defined utilising the outcomes of the Task 1.2 (D1.3).

- **Objectives Definition**

Following the Balanced Scorecard framework, the four main perspectives—customer, *internal processes*, *learning and growth*, and *financial*—are the primary categories under which lagging and leading indicators are formulated to integrate environmental and social aspects into the SBSC and

assess their performance.[1] To this end, the objectives of each industry are defined within the spectrum of the Plooto Sustainability and Governance perspectives. This spectrum combines the ESG (environmental, social, and governance) considerations, the four Balanced Scorecard perspectives, the economic and growth objectives specific to each industry, and its specialized opportunities.
In Plooto SBSC, this step is defined utilising the outcomes of the Task 1.2 (D1.3).

- **Strategic Mapping**

The Strategic Mapping step aims to introduce the cause-and-effect links between the strategic objectives defined in the previous stage. The industry focuses on the key objectives that is envisioning to achieve for being more sustainable and to accelerate circularity. Within this step, the interconnections between the strategic objectives are outlined at high level, and being materialised in the next step, in identifying the relevant KPIs.
In Plooto SBSC, this step is defined utilising the outcomes of the Plooto Framework (D1.3) and according to the selection/preferences of the pilot partners.

- **Key Performance Indicators/Materialised Targets**

One of the most critical steps is the selection of KPIs for measuring properly the performance of the measures/aspects of interest. Under the Plooto SBSC, the KPIs have been identified and described during the development phase of the Plooto Sustainability and Governance Framework, in D1.3. In this deliverable, an extended list of the KPIs has been created, based on a thorough investigation and analysis of the existing ESG frameworks, as well as relevant frameworks close to sustainability and circularity assessment of industries. This list embraces all the main principles/categories referred in the *Objectives Definition* step, for delivering a comprehensive catalogue of indicators, capable to being adapted and measured by the majority of the industrial value chains. The KPIs are the materialised targets that will measure/assess the current actions and/or operational status of each investigated industry/value chain, providing a reliable representation of its current situation or the potential improvements that the industry is capable to elaborate.
In Plooto SBSC, this step is defined by utilising the outcomes of the Plooto Framework (D1.3) and according to the selection/preferences of the pilot partners.

- **Strategic Processes Identification**

This step focuses on identifying the critical processes that are involved into the cause-and-effect pattern that defined in the previous step, and the connection of each KPI, with the process(es) that affect its performance. Since the KPIs are set for each industry, the *source* for their measurement should be detected and determined. In the case of industrial value chains, the individual processes across the chain play the role of the source. One KPI can be detected or calculated by more than one processes, indicating the complexity of structuring a reliable and representative cause-and-

[1] The lagging indicators indicate whether the strategic objectives have been achieved in each of the four perspectives, the leading indicators express the specific competitive advantages of the industry and represent how the results should be achieved [2].

effect pattern. To ensure the inclusion in the SBSC of a reliable and representative flow of processes, the Process Modelling and Simulation Service will serve as the cornerstone, on which the Plooto SBSC will be built on. The individual processes of each investigated value chain are virtually represented through the Plooto PSM Tool, and all the processes are modelled, as presented in the D2.3. This step is a mandatory, preparatory component for the forthcoming step, the cause-and-effect modelling.
In Plooto SBSC, this step is defined utilising the Process Modelling and Simulation Services (WP2-D2.3) and the use of the Plooto PSM Tool.

- **Data and Integration**

Aiming to deliver a reliable and effective cause-and-effect model, a thorough analysis of the processes/components of the value chain is mandatory to identify the necessary technical specifications and data, that will be integrated into the SBSC. Based on the defined value chain, the involved processes and actors, and the targeted KPIs, specific data are requested from the pilot partners for creating a trustworthy model. The requested data are sets of hourly timeseries relevant to the defined dependent and independent variables (see Section 0). The objective is to cover an operational time period of one month minimum, in order to provide a reliable model and create trustworthy equations, which will be discussed in the next step, the cause-and-effect modelling.
In Plooto, this step is defined utilising the Process Modelling and Simulation service and the PSM Tool for delivering the SBSC module.

- **Cause-and-effect modelling**

Leveraging on the previous steps (KPIs, processes determination and data), this step seeks to quantify the interconnections between the KPIs across the value chain, structuring the cause-and-effect model. This model allows for the analysis of the impact on the overall value chain performance when modifying a KPI, essentially performing a what-if analysis. The cause-and-effect model is realised and becomes a practical tool through the PSM Tool. To accomplish this, and as described more analytically in the D2.3, process specific equations are defined to develop the models for each process of the value chain, enclosing the necessary *coefficients* that devote the developed and established among the relevant (to the model) KPIs. Therefore, the cause-end-effect model is formed through the calculation of the *coefficients*. Specifically, it is included in the modelling and simulation results and then is feed in the CRIS platform through the PSM tool (as described in D3.3).
An indicative visualisation of the cause-and-effect relationship between the KPIs, is presented in Figure 3. It showcases some of the selected KPIs of a specific Plooto use case (the citrus processing waste for juice by-products), how the KPIs are interrelated, which KPI affects another KPI, and the character of this affection (increase, decrease, etc.)

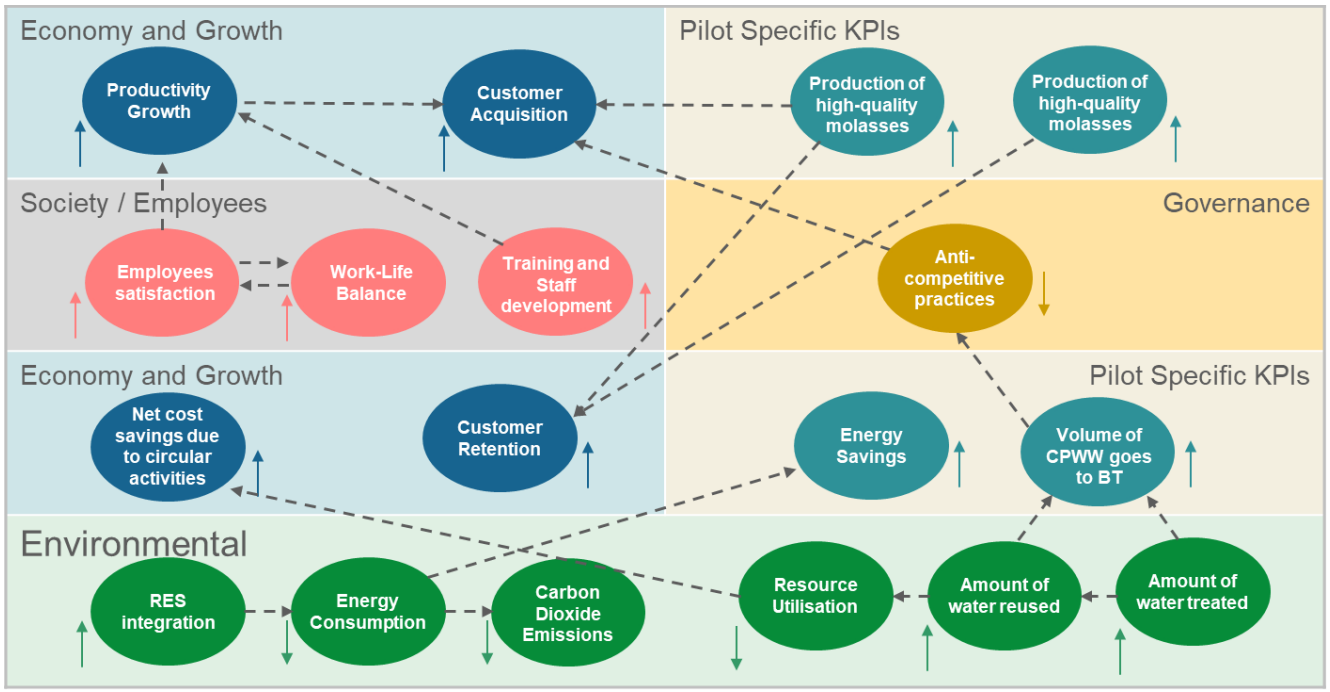

Figure 3: Example of cause-and-effect visualisation in a specific use case

(arrows pointing upwards indicate the increase, arrows pointing upwards the decrease)

As Figure 3 shows, the selected KPIs that represent the main thematic of the Plooto Sustainability & Governance Framework (environment, society, economy and growth, governance) and interconnected, affecting the performance of one another KPI. For example, the amount of water treated affects the amount of water reuse (increased amount of treated water leads to increased amount of reused water), and both affect the volume of CPWW that goes to Biological Treatment (BT). The management of CPWW, which goes to the BT, decreases the proportion of anti-competitive practices that the industry might consider (i.e., the volume of water discharged into the nearest water body), which comprises a law violation. The avoidance of such actions could play a critical role in new customers acquisition, affecting therefore, the productivity growth of the overall industry. *In Plooto SBSC, this step is defined by the tailored SBSC Module that is developed within the PSM Tool.*

- **Performance Analysis**

The last step of the Plooto SBSC development, is the performance analysis of the investigated value chain. It performs the calculation of KPIs by executing the cause-and-effect model, which delivers the coefficients' calculations and extracts the values to be transported into the CRIS platform. This final step includes also the interconnection with the visualisation of the SBSC and the WP2 services. Following the completion of the performance analysis, the option exists to re-execute the implementation steps, selecting or involving of a new set of KPIs or shifting towards alternative objectives. The performance analysis is the final step of the (first) iteration of the SBSC. The implementation steps are outlined the overall approach that has been followed in order to develop and deliver the Plooto Balanced Scorecard. Considering the project's objectives and required

outcomes, the Scorecard is designed as a comprehensive tool, that will carry out the environmental and circularity assessment across the value chain, therefore, serving as an "one-stop-shop tool".

2.3 Plooto Balanced Scorecard Architecture

The architecture of the SBSC system in Plooto builds upon the implementation steps described in the previous sub-section, focusing mainly on the visualisation of a structured approach. This approach aims to support and transform a generic balanced scorecard from a conceptual framework for performance management into a tailored tool for assessing the circularity and sustainability of a value chain. To this end, the architecture of the SBSC system is in line with the overall architecture of the CRIS Platform (D1.5) and the Plooto Services (D2.3), and is realised according to the following diagram:

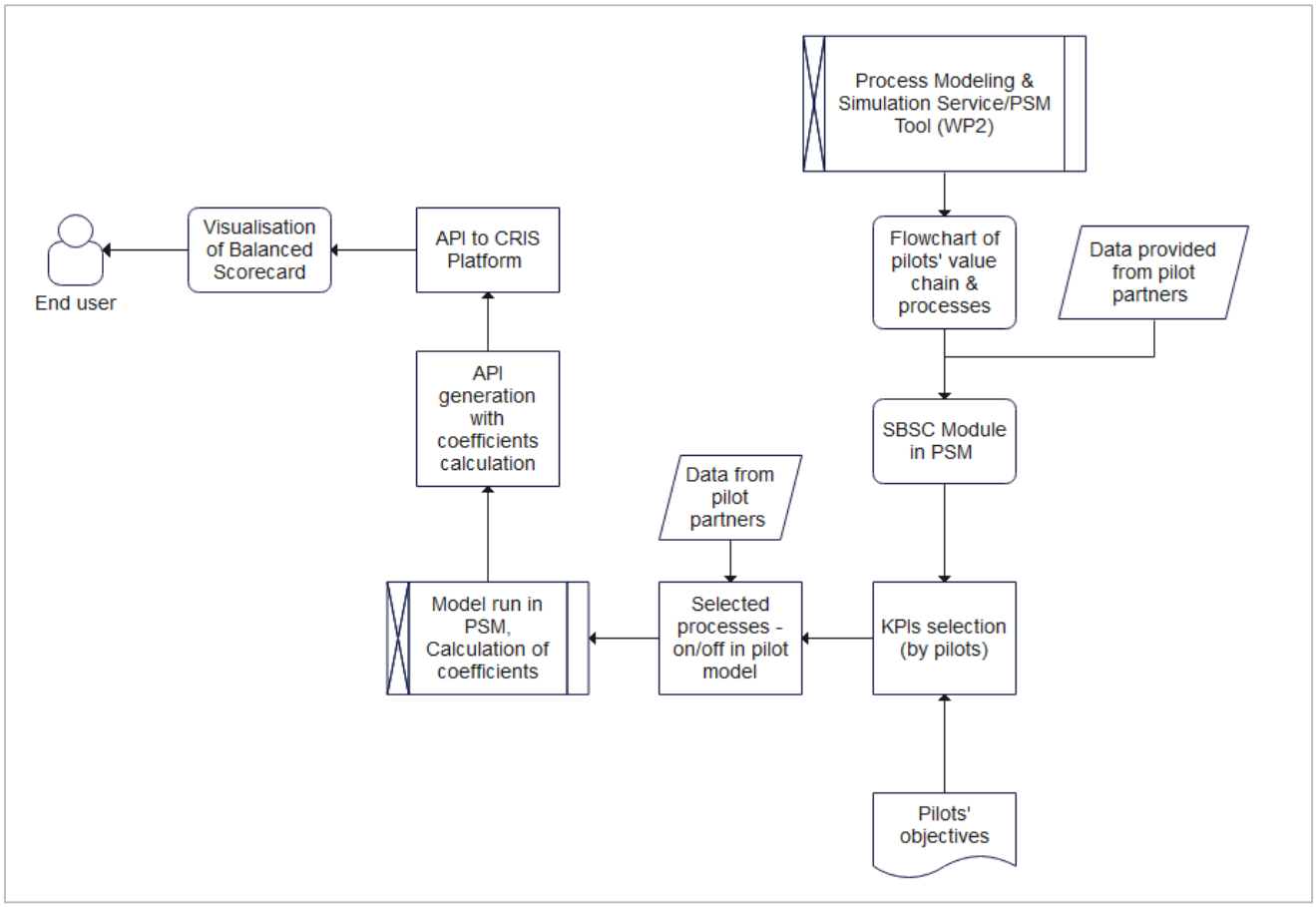

Figure 4: Plooto Balanced Scorecard Architecture Diagram

The scorecard architecture utilises the Process Modelling and Simulation tool (D2.3, WP2 services), the flowcharts per pilot designed and developed through the process modelling and simulation service and the necessary data to build the value chain model per pilot. The module of SBSC enables the selection of the KPIs which are defined by the pilots, considering their preferences and objectives. These objectives or perceptions could be reported in a file (such as an excel file) and are reflected in the KPIs selection.

The PSM model, as a virtual representation of the physical value chain, through its actor capability, can enable or disable some of the process flows, including or excluding processes and their connected KPIs, serving as an adaptable tool, according to the available data and preferences provided by the pilot partners. The PSM models have been developed and adopted to the investigated value chain per pilot, and the coefficients that determine the cause-and-effect pattern, have been integrated into those models. Therefore, upon the completion of the simulation, the results provide the required values for the calculations, which are visualised through the SBSC Module of the PSM, but also are available through the API and the JSON file that is produced via the PSM. The JSON file is the data transportation mean through the PSM and the CRIS platform, which visualises the results of the coefficients and materialises the cause-and-effect pattern. The visualisation provides all the critical information for the value chain, considering the selected KPIs and the involved processes. If necessary, different scenarios could be investigated, according to the data provided by the pilot partners, the KPIs selection, or the objectives' defined per pilot. The end user, therefore, has access to a comprehensive analysis and assessment of the value chain.

3 Adapting the Balanced Scorecard to the Pilots

Plooto involves three diverse, high-potential pilot use cases, to investigate the opportunities which arise on waste reduction, end-to-end traceability, decision-making, monitoring and certification. The SBSC is designed as a versatile, tailor-made tool, that can be smoothly implemented across diverse process industries. Consequently, customised input data per industry is required, for the construction of an industry-specific Balanced Scorecard. Considering the implementation steps described and the system architecture, the user-configurable information and data are presented in Table 1 below.

Table 1: User-configurable information

Balanced Scorecard Framework Related	Process Modelling and Simulation Service Related
Identification of the industry's objectives for sustainability and circularity	Indication of the industrial processes involved in the value chain of the industry
Identification of the industry's targets from the traceability strategies	Creation of the flowchart with involved processes per pilot
Selection of targeted KPIs	Technical and operational data relevant to the processes

The subsequent tables, presented per pilot, accumulate all the necessary information and critical data that gathered to entered into the SBSC module in the PSM Tool and create the API to be transported to the CRIS platform and enable the visualisations.

3.1 Citrus Processing Waste for Juice By-Products

Table 2 showcases the necessary information and data for the SBSC of the *Citrus Processing Waste for Juice By-Products*. The main objective of this pilot use case focuses on the enabling of the waste reusability within the process line, mainly in producing cattle feed exploiting the citrus peels waste. The Greek pilot is also foreseen to boost the production of a high-quality molasses, that will provide a competitive advantage at local and national level. Therefore, the traceability strategy of this pilot is oriented in capitalising growth opportunities and enhance circularity and reusability of industrial waste. The table presents the selected by the pilot KPIs, which were indicated during the circulation of the SBSC checklists, based on the extended KPIs list that was delivered through the D1.3 (Appendix A), and the identified process, in which, the KPIs is detected and will be calculated. Considering the architecture presented in the previous section, the majority of the KPIs are calculated by the PSM Tool models, utilising the necessary regression equations for each of the process. At the same time, some of the KPIs are inserted manually since they are quantitative values/estimations, that are connected to specified actors.

Once the connected processes and the regression model equations have been identified, the corresponding coefficient for each process of the model is defined. Across the value chain, for each one of the involved processes, there is a *dependent* and an *independent* variable; the dependent variable is the controlled variable representing the *cause* in the cause-and-effect relationship, and

the independent variable is the measured or observed variable representing the effect. Therefore, the next table related to the Greek pilot (Table 3) presents the process included in the flowchart and connected with the pilot, the dependent and independent variables, the input and output of each process in the PSM tool, and the connected processes. Figure 5 is a textual representation of the flowchart associated with the Greek pilot.

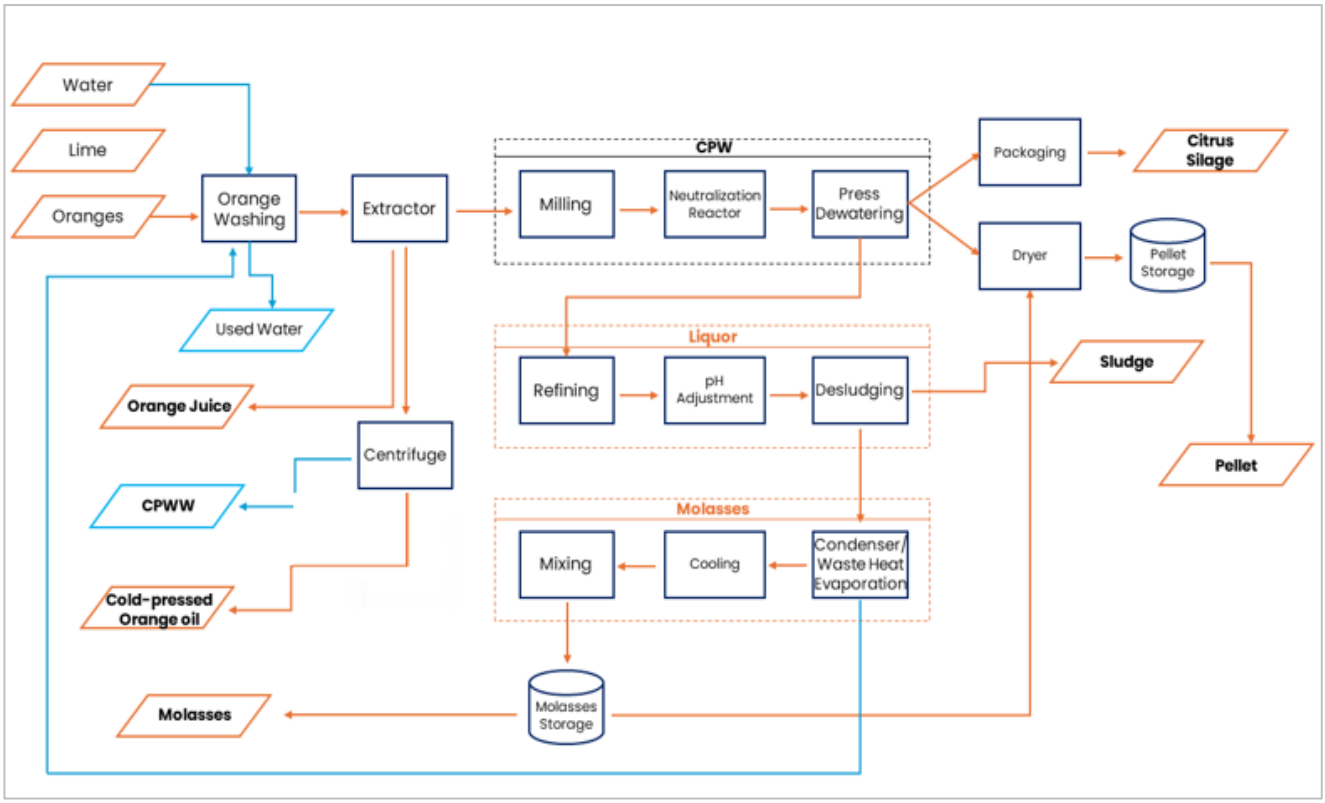

Figure 5: Greek Pilot Flowchart – *Citrus Processing Waste for Juice By-Products*
(retrieved from D2.3 Process Modelling and Simulation Service)

Table 2: Greek Pilot KPIs - Citrus Processing Waste for Juice By-Products

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for subcategory	Affected KPIs	Cause-and-effect Category	Connected Processes	KPI calculation from PSM Tool	Type of calculation for visualisation
Carbon Dioxide (CO_2)	PLE01	Environment	Amount of CO_2 from the activities across the supply chain	kgeq	Carbon footprint	PLE06, PLE11, PLE17, PLES08	Sustainability	Extractor, Centrifuge, CPW, Liquor Processing, Molasses Processing, Dryer	Yes	PSM Tool
Water stress/ consumption	PLE03	Environment	Amount of water consumed across the industrial processes	kg	Resources	PLE03, PLE04, PLE05, PLGR06	Sustainability	Extractor, Centrifuge, CPW	Yes	PSM Tool
Amount of water reused	PLE04	Environment	Amount of water reused across the industrial processes	kg	Resources	PLE03, PLE04, PLE05	Circularity, Sustainability	Molasses Processing	Yes	PSM Tool
Amount of water treated	PLE05	Environment	Amount of water treated before returning to the ecosystem	kg	Resources	PLE03, PLE04, PLE05	Circularity, Sustainability	Molasses Processing	Yes	PSM Tool
Energy consumption	PLE06	Environment	Amount of energy consumed across the supply chain	kWh	Resources	PLE01, PLE02, PLE03, PLE04, PLE05	Sustainability	Extractor, Centrifuge, CPW, Liquor Processing, Molasses Processing, Dryer	Yes	PSM Tool
Fossil fuels depletion	PLE08	Environment	Amount fossil fuels reduction (or energy from RES) in consumed energy mix	kg or kWh	LCA/ Resources	PLE01, PLE06	Sustainability, Resiliency	Extractor, CPW, Dryer, Liquor, Processing	Yes	PSM Tool
Packaging materials and waste rate	PLE14	Environment	Efficiency of Packaging Materials used	%	Pollution and Waste	PLE01	Sustainability	Packaging	Yes	PSM Tool (By calculating the amount of waste and considering the information about packaging materials)
ISO22400 for KPIs in Manufacturing Operations Management	PLE19	Environment	ISO Certification that the company/industry meets the certification standards	-	Opportunities and Innovation	PLS05	Sustainability, Resiliency, Transparency	Extractor, Centrifuge, CPW, Liquor, Processing, Molasses Processing, Dryer, Packaging	Yes	PSM Tool (Checking the operational parameters) *Connection with affected KPIs***
ISO59020 for measuring and assessing circularity	PLE20	Environment	ISO Certification that the company/industry meets the certification standards	-	Opportunities and Innovation	PLGE01, PLGR06, PLE04, PLE05, PLEG03	Circularity	Centrifuge, Molasses Processing, Packaging	Yes	PSM Tool (Checking the operational parameters) *Connection with affected KPIs***
Health and Safety	PLS01	Society	Assessment health and safety conditions in the industrial company	Qualitative	Human Capital	PLE19	Resiliency	Qualitative from measurements/questionnaires	No	Constant Value in PSM (Questionnaire) *Connection with affected KPIs***

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for subcategory	Affected KPIs	Cause-and-effect Category	Connected Processes	KPI calculation from PSM Tool	Type of calculation for visualisation
Training and Staff development	PLS03	Society	Availability and implementation of training programs and staff development activities	No. of trainings	Human Capital	PLS05, PLS10, PLS11, PLEG01, PLG04, PLEG05, PLEG08, PLEG09	Resiliency	Quantitative from measurements/questionnaires	No	Constant Value in PSM (Questionnaire)
Product safety and quality	PLS05	Society	The industrial company meets the standards for product safety and quality	Qualitative	Product Assessment	PLE19, PLE20	Resiliency, Traceability	Qualitative from PSM after integrating actors	Yes	Constant Value in PSM (By setting a threshold/ Characteristic value, and its performance) *Connection with affected KPIs***
Transparency within the Supply Chain	PLS07	Society	The level of transparency regarding the quality and origin of the materials, the processing, etc.	Qualitative	Product Assessment	ALL	Transparency	ALL the processes of the investigated line	Yes	PSM Tool (By inserting information about origin & quality of material, and the quality of operational processes)
Customer satisfaction	PLS10	Society	Level of satisfaction of costumers from the product use	Qualitative	Stakeholders	PLS03, PLS05, PLS07, PLGR02, PLEG05, PLEG09	Resiliency	Qualitative from PSM after integrating the actors	Yes	Constant Value in PSM (Questionnaire) *Connection with affected KPIs***
Employee satisfaction	PLS11	Society	Level of satisfaction of employees in the company	Qualitative	Human Capital	PLS01, PLS03, PLS14, PLEG09	Resiliency	Qualitative from measurements/questionnaires	No	Constant Value in PSM (Questionnaire)
Work-Life Balance	PLS14	Society	Level of balance between professional responsibilities and personal time Qualitative Opportunities Resiliency	Qualitative	Opportunities	PLS11, PLEG08	Resiliency	From PSM	Yes	PSM Tool (considering the working hours per shift, e.g. 8h per 5days)
Anti-competitive practices	PLG02	Governance	Number of practices that an industrial company follows to gain an advantage in the market or to circumvent the law (i.e., price fixing, waste deposit to the sea/rivers etc.)	Number of practices applies in a year	Corporate Behaviour	PLE04, PLE05, PLS05, PLS07, PLGR06	Transparency	ALL the processes of the investigated line	Yes	PSM Tool (Numbering the practices) *Connection with affected KPIs***
Market share	PLEG01	Economy & Growth	The percentage of sales of a product related to all sales of that product for a specific time period, i.e., per month, and for a specific geographic area (i.e., at national level)	*	Finance	PLS10, PLEG04, PLEG05	Economic Advantage	Quantitative from measurements/questionnaires	No	PSM Tool (Assessing percentage in relevance to production)

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for subcategory	Affected KPIs	Cause-and-effect Category	Connected Processes	KPI calculation from PSM Tool	Type of calculation for visualisation
Net cost savings *due to circular activities (only for pellets)*	PLEG03	Economy & Growth	Assessment of savings that coming from circular activities (i.e., re-use of materials or secondary raw materials, treatment of water to enter the process, etc.)	€	Finance	PLGE01, PLGR01	Economic Advantage, Circularity	Extractor, CPW, Dryer, Molasses Processing	Yes	PSM Tool (Assessing incomes in relevance to production)
Customer acquisition	PLEG04	Economy & Growth	Number of new incoming customers per year	N°	Customer	PLEG01, PLS10, PLS07	Resiliency	Quantitative from measurements/questionnaires	No	Constant Value in PSM (Questionnaire)
Customer retention	PLEG05	Economy & Growth	Perception of customers remaining or leaving, per year or specific period	% (±)	Customer	PLS03, PLS10, PLEG01	Economic Advantage, Resiliency	Quantitative from measurements/questionnaires	No	Constant Value in PSM (Questionnaire)
Productivity growth	PLEG08	Economy & Growth	Percentage of increase in output/value generated per unit, for a specific time period	%	Growth perspective	PLS03, PLS14	Economic Advantage	From PSM after integrating actors	Yes	PSM Tool (Assessing in relevance to PLS03, PLS14) *Connection with affected KPIs***
Revenue growth	PLEG09	Economy & Growth	Percentage of increase in revenues/sales generating income, for a specific time period	%	Growth perspective	PLS03, PLS10, PLS11	Economic Advantage	From PSM after integrating actors	Yes	PSM Tool, inserting the information for sales over a year
Production of animal feed	PLGR01	Pilot Specific KPI	Amount of production of animal feed	tons	Pilot specific KPI	PLE06, PLE14, PLE19, PLE20, PLG03, PLEG01	Economic Advantage	Extractor, CPW, Dryer	Yes	PSM Tool (Calculation of production)
Production of high-quality molasses	PLGR02	Pilot Specific KPI	Amount of production of high-quality molasses	tons	Pilot specific KPI	PLE19, PLS05, PLS07, PLS10	Economic Advantage, Resiliency	Extractor, CPW, Liquor Processing, Molasses Processing	Yes	PSM Tool (Assessment of the quality)
Volume of CPWW that goes to biological treatment	PLGR06	Pilot Specific KPI	Amount of CPWW that goes to biological treatment	%	Pilot specific KPI	PLE03, PLE04, PLE05, PLE20	Sustainability, Transparency	Extractor, Centrifuge	Yes	PSM Tool (Calculation of production)
Improve energy savings	PLGR08	Pilot Specific KPI	Percentage of energy savings (compared to the baseline energy consumption)	%	Pilot specific KPI	PLE06, PLE08	Sustainability	Extractor, Centrifuge, CPW, Liquor Processing, Molasses Processing, Dry er, Packaging	Yes	PSM Tool (Calculation considering Optimisation/Analytics scenario)

* *Depends on the case/ available data, usually in € per specific month, per specific area*

** *The connection with affected KPIs means that for the calculation/assessment of the value for this KPI, the affected KPIs will be utilised*

Table 3: Greek Pilot Processes and Variables

Processes in GR Pilo0t	Dependent Variable	Independent Variables	Input of the process (in PSM)	Output of the process (in PSM)	Connected Processes (in the PSM Model)	Connected KPIs
Orange Washing	Mass of washed oranges	Mass of dirt/waste, Water Pressure, Washing Time, Energy Consumption	Mass of oranges, Mass of water, mass of lime (from ASPIS model)	Mass of washed oranges	Extraction	Carbon Dioxide (CO_2), Water stress/ consumption, Amount of water reused, Amount of water treated, Energy consumption
Extraction - Orange Juice	Mass of orange juice - concentrate	Mass of washed oranges, Pressure, Extraction Efficiency, Energy Consumption	Mass of washed oranges	Mass of orange juice - extracted	Orange Washing, Centrifugation	Carbon Dioxide (CO_2), Energy consumption
Extraction - to CPW	Mass of CPW - Citrus peels	Mass of washed oranges, Pressure, Extraction Efficiency, Energy Consumption	Mass of washed oranges	Mass of CPW (citrus peels water)	Orange Washing, Milling - CPW	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity
Centrifuge - to CPWW	Mass of CPWW - Citrus peel wastewater	Mass of orange juice, Centrifuge Speed, Mass of bottom pulp, Energy Consumption	Mass of orange juice - extracted	Mass of CPWW - Citrus peel wastewater	Extraction	Carbon Dioxide (CO_2), Energy consumption, Water stress/ consumption, ISO22400 for KPIs in Manufacturing Operations Management, Volume of CPWW that goes to biological treatment
Centrifuge – to Orange Oil (final product 1)	Mass of Orange Oil	Mass of orange juice, Centrifuge Speed, Mass of bottom pulp, Energy Consumption	Mass of orange juice – extracted	Mass of Orange Oil	Extraction	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, ISO59020 for measuring and assessing circularity
Centrifuge - Orange juice (final product 2)	Mass of clarified orange juice	Mass of orange juice, Centrifuge Speed, Energy Consumption	Mass of orange juice - extracted	Mass of clarified juice - final product 1	Extraction	Carbon Dioxide (CO_2), Energy consumption, ISO22400 for KPIs in Manufacturing Operations Management, Health and Safety, Product safety and quality, Transparency within the Supply Chain
Milling – CPW	Mass of CPW - *citrus peels*	Remaining mass of peels after extraction, Milling Efficiency, Water content of oranges, Energy Consumption	Mass of CPW	Mass of milled citrus pills	Extraction, Neutralisation - CPW	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity
Neutralisation - CPW	pH of neutrilised CPW (pH)	Concentration of acid, Concentration of base, Temp of CPW, Energy Consumption	Mass of milled citrus peels	pH of neutrilised CPW (pH)	Milling - CPW, Press Dewatering - CPW	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity
Neutralisation - CPW	Mass of neutrilised CPW	Mass of acid ($Ca(OH)_2$), Mass of peels Temp of CPW, pH of CPW, Energy Consumption	Mass of milled citrus peels	Mass of neutrilised CPW	Milling - CPW, Press Dewatering - CPW	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity
Press Dewatering - CPW (peels)	Mass of citrus peels	Pressure, Time of pressing, Moisture content of citrus peels, Energy Consumption	Mass of neutrilised CPW	Mass of citrus peels	Neutralisation - CPW, Drying, Packaging	Carbon Dioxide (CO_2), Water stress/ consumption, ISO59020 for measuring and assessing circularity
Press Dewatering - CPW (liquor)	Mass of press liquor	Pressure, Time of pressing, Moisture content of citrus peels, Energy Consumption	Mass of neutrilised CPW	Mass of press liquor	Neutralisation - CPW, Refining - Liquor	Carbon Dioxide (CO_2), Water stress/ consumption, ISO59020 for measuring and assessing circularity

Processes in GR Pilo0t	Dependent Variable	Independent Variables	Input of the process (in PSM)	Output of the process (in PSM)	Connected Processes (in the PSM Model)	Connected KPIs
Refining - Liquor	Mass of suspended solids removed	Temperature, Refining time, Energy Consumption	Mass of press liquor	Mass of refined liquor	Press Dewatering - CPW, pH Adjustment - Liquor	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity
pH Adjustment - Liquor	pH of adjusted liquor	Volume of acidulant, temperature of liquor, time, Energy Consumption	Mass of refined liquor	pH of adjusted liquor	Refining - Liquor, Desludging - Liquor	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity
Desludging - Liquor	Mass of solids removed - Mass of sludge	Mass of clarified juice, Desludging Temperature, Desludging Time, Energy Consumption	Mass of refined liquor	Mass of sludge	pH Adjustment - Liquor, Evaporation/Condenser - Molasses	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity
Desludging - Liquor	Mass of Molasses	Mass of clarified juice, Desludging Temperature, Desludging Time, Energy Consumption	Mass of refined liquor	Mass of Molasses	pH Adjustment - Liquor, Evaporation/Condenser - Molasses	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity
Evaporation/Condenser - Molasses	Mass of Molasses from Evaporation	Evaporation Temperature, Evaporation Time, Energy Consumption	Mass of Molasses	Mass from molasses from evaporation	Desludging - Liquor, Cooling - Molasses	Carbon Dioxide (CO_2), Water stress/ consumption, Amount of water reused, Energy consumption, ISO59020 for measuring and assessing circularity
Cooling - Molasses	Temperature of Molasses	Mass of Molasses, Mass of water added, Temp of cooling water, Mixing Time, Energy Consumption	Mass from molasses from evaporation	Temp of molasses	Evaporation/Condenser - Molasses, Storage	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity
Mixing - Molasses						
Cooling and mixing - molasses final product	Mass of molasses - final product 2	Mass of molasses, Temp of molasses, Energy Consumption	Mass from molasses from evaporation	Mass of molasses (final product 2)	Evaporation/Condenser - Molasses, Storage	Carbon Dioxide (CO_2), Energy consumption, ISO59020 for measuring and assessing circularity, Health and Safety, Product safety and quality, Transparency within the Supply Chain, Production of high-quality molasses
Drying	Mass of dried solids	Mass of solids, Drying Temp, Drying Time, Energy Consumption	Mass of molasses + mass of peels	Mass of pellets	Press Dewatering - CPW, Storage	Carbon Dioxide (CO_2), Energy consumption
Packaging **	NA	Volume of waste	Mass of packaging material	N/A	Press Dewatering - CPW	Carbon Dioxide (CO_2), Energy consumption, , Product safety and quality, Transparency within the Supply Chain,
Storage (Molasses)**	NA	Temp	Mass of produced molasses	N/A	Storage (Molasses)	Carbon Dioxide (CO_2), Energy consumption, , Product safety and quality, Transparency within the Supply Chain,
Storage (Pellets)**	NA	Temp	Mass of produced pellets	N/A	Storage (Pellets)	Carbon Dioxide (CO_2), Energy consumption, , Product safety and quality, Transparency within the Supply Chain,

**Calculation is directly connected with affected KPIs*

***Packaging, Storage of Molasses and Storage of Pellets are final processes as shows Figure 4, therefore there is not depended variable, or output process connected*

3.2 WEEE for Magnets

The next Plooto use case focuses on the reuse of Waste from Electrical and Electronic Equipment (WEEE) for magnets production. The main goal of this pilot is to optimise magnet processing and explore requalification of magnets in terms of investigating the properties and their stability over time, the quality, etc. To this end, the SBSC of the Spanish pilot targets to evaluate the magnets production efficiency and showcase the evaluation results, as a quality verification of the produced magnets. The three involved companies/project partners, Ferimet, IMA and IMDEA, together with the pilot supporter, EUT, concentrate on producing high-quality and certified magnets in order to meet the high expectations of their customers. Within this scope, the selected KPIs for the SBSC embrace the aspects of environment, governance, economy and growth, and the pilot specific indicators, as presented in Table 4.

Similarly to the Greek pilot, once the connected processes and the equations for the regression models have been identified, the next steps include the calculation of the coefficients that are interconnected to each process. Table 5 introduces the depended and independent variables, the connected processes, the calculation method or source, and all the critical information that is necessary for creating the SBSC of this pilot use case.

At this point, the model of the magnets' production line is to be finalised. Therefore, all relevant information to the processes is indicative, and this is noted on Table 4 & Table 5, where necessary.

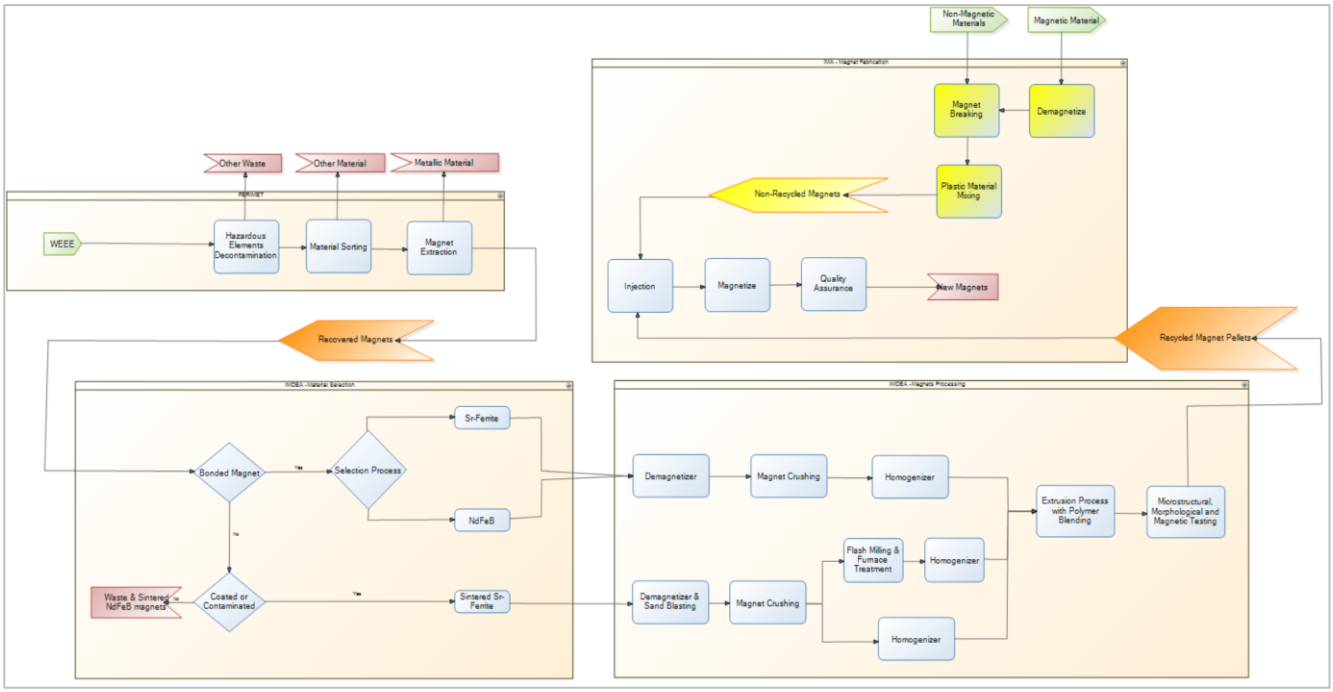

Figure 6: Spanish Pilot Flowchart – *WEEE for Magnets*
(retrieved from D2.3 Process Modelling and Simulation Service)

Table 4: Spanish Pilot KPIs – *WEEE for Magnets*

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for subcategory	Affected KPIs	Cause-and-effect Category	Connected Processes *Indicative*	KPI calculation from PSM	Type of calculation for visualisation
Carbon Dioxide (CO_2)	PLE01	Environment	Amount of CO_2 released from the activities across the supply chain	kg_{eq}	Carbon footprint	PLE06, PLE09, PLE17	Sustainability	Demagnetizer, Magnet Crushing, Homogenizer, Demagnetizer & Sand Blasting, Flash Milling & Furnace Treatment, Extrusion Process with Polymer Blending, Injection, Magnetise, Magnet Breaking, Plastic Material Mixing	Yes	PSM Tool
Water stress/ consumption	PLE03	Environment	Amount of water consumed across the industrial processes	kg	Resources	PLE04, PLE17, PLG02	Sustainability	*To define and confirm the indirect uses of water across the production line*	Yes	PSM Tool
Amount of water reused	PLE04	Environment	Amount of water reused across the industrial processes	kg	Resources	PLE03, PLE17, PLEG02	Circularity, Sustainability	*To define and confirm the indirect uses of water across the production line*	Yes	PSM Tool
Energy consumption	PLE06	Environment	Amount of energy consumed across the supply chain	kWh	Resources	PLE07, PLE09, PLE14, PLE17, PLES02, PLES04	Sustainability	Demagnetizer, Magnet Crushing, Homogenizer, Demagnetizer & Sand Blasting, Flash Milling & Furnace Treatment, Extrusion Process with Polymer Blending, Injection, Magnetise, Magnet Breaking, Plastic Material Mixing	Yes	PSM Tool
Use of RES/RES integration	PLE07	Environment	Amount of energy produced by RES	kWh	LCA/Resources	PLE06, PLE17	Sustainability, Resiliency	Demagnetizer, Magnet Crushing, Homogenizer, Demagnetizer & Sand Blasting, Flash Milling & Furnace Treatment, Extrusion Process with Polymer Blending, Injection, Magnetise, Magnet Breaking, Plastic Material Mixing	Yes	PSM Tool
Transportation processes	PLE09	Environment	Consumptions related to the transportation/logistics (i.e., energy)	-	Resources	PLE01, PLE06, PLS07	Sustainability	From actor Ferimet to actor IMDEA (Material Selection), from actor IMDEA (Magnets processing) to actor IMA (magnets fabrication)	Yes	PSM Tool
Use of biodegradable materials	PLE13	Environment	Number of biodegradable materials produced/used	kg	Pollution and Waste	PLE17, PLE18, PLS05, PLS07	Circularity	Plastic Material Mixing, Packaging (New Magnets)	Yes	PSM Tool (Constant value, data provided by the Pilot)
Packaging materials and waste	PLE14	Environment	Amount of waste from packaging material	kg	Pollution and Waste	PLE18, PLS05, PLS07, PLE17	Sustainability	Packaging (New Magnets), Magnet Extraction (from actor Ferimet to actor IMDEA)	Yes	PSM Tool (By calculating the amount of waste and considering the information about packaging materials)
Electronic Waste	PLE15	Environment	Amount of electronic waste	kg	Pollution and Waste	PLE18, PLS07, PLE17	Sustainability	Magnet Extraction (actor Ferimet)	Yes	PSM Tool (Constant value, data provided by the Pilot)

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for subcategory	Affected KPIs	Cause-and-effect Category	Connected Processes *Indicative*	KPI calculation from PSM	Type of calculation for visualisation
Scrap Waste	PLE16	Environment	Amount of scrap waste	kg	Pollution and Waste	PLE17, PLE15, PLES02, PLES04	Sustainability	Material Sorting, Magnet Extraction, Bonded Magnet_Material Selection, Coated/Contaminated, Material Sorting, Magnet Extraction, Bonded Magnet_Material Selection, Coated/Contaminated_Material Selection, Microstructural, Morphological & Magnetic Testing, Injection	Yes	PSM Tool (Constant value, data provided by Pilot or calculation through the material flow analysis approach)
Resource Utilization	PLE17	Environment	Percentage of use of non-renewable resources across the supply chain	%	Resources	PLE04, PLE05, PLE14, PLE15, PLE16	Sustainability, Resiliency, Circularity	All the processes across the value chain, from all three actors involved	Yes	PSM Tool *Connection with affected KPIs***
Consumption of virgin raw materials	PLE18	Environment	Amount of virgin raw material consumed	kg	Resources	PLES02, PLES04	Sustainability, Resiliency, Circularity	Flash Milling & Furnace Treatment, Extrusion Process with Polymer Blending, Injection, Plastic Material Mixing	Yes	PSM Tool (Constant value, data provided by the Pilot (Ferrimet))
Health and Safety	PLS01	Society	Assessment health and safety conditions in the industrial company	Qualitative	Human Capital	PLS11	Resiliency	Qualitative from measurements/questionnaires	No	Constant Value in PSM (Questionnaire) *Connection with affected KPIs***
Training and Staff development	PLS03	Society	Availability and implementation of training programs and staff development activities	No. of trainings	Human Capital	PLS11	Resiliency	Quantitative from measurements/questionnaires	No	Constant Value in PSM (Questionnaire)
Product safety and quality	PLS05	Society	The industrial company meets the standards for product safety and quality	Qualitative	Product Assessment	PLG04	Resiliency, Traceability	Qualitative from PSM after integrating actors	Yes	PSM Tool (Adherence to the ISO compliance - ISO16949 / Product Traceability by setting a threshold/ characteristics value and measuring the performance
Transparency within the Supply Chain	PLS07	Society	The level of transparency regarding the quality and origin of the materials, the processing, etc.	Qualitative	Product Assessment	PLE09, PLE13, PLE14, PLE15	Transparency	ALL the processes of the investigated line	Yes	PSM Tool (By inserting information about origin & quality of material, and the quality of operational processes) *Connection with affected KPIs***
Supply Chain Liability	PLS09	Society	The legal responsibility of the industrial company for actions or shortcomings across its supply chain	Qualitative	Stakeholders	PLS05, PLS07	Transparency, Traceability	Qualitative from PSM after integrating the actors	Yes	PSM Tool (Constant value, according to industry's

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for subcategory	Affected KPIs	Cause-and-effect Category	Connected Processes *Indicative*	KPI calculation from PSM	Type of calculation for visualisation
										compliance with national regulations)
Customer satisfaction	PLS10	Society	Level of satisfaction of costumers from the product use	Qualitative	Stakeholders	PLS05, PLS07, PLG04, PLG05	Resiliency	Qualitative from PSM after integrating actors	Yes	Constant Value in PSM (Questionnaire) *Connection with affected KPIs***
Employee satisfaction	PLS11	Society	Level of satisfaction of employees in the company	Qualitative	Human Capital	PLS01, PLS03, PLS14	Resiliency	Qualitative from measurements/questionnaires	No	Constant Value in PSM (Questionnaire)
Work-Life Balance	PLS14	Society	Level of balance between professional responsibilities and personal time	Quantitative	Opportunities	PLS01, PLS11	Resiliency	From PSM	Yes	PSM Tool (Considering the working hours per shift (e.g. 8h per 5days))
Anti-competitive practices	PLG02	Governance	Number of practices that an industrial company follows to gain an advantage in the market or to circumvent the law (i.e., price fixing, waste deposit to the sea/rivers etc.)	Number of practices applies in a year	Corporate Behaviour	PLEG04, PLS05	Transparency	ALL the processes of the investigated line	Yes	PSM Tool (Numbering the practices) *Connection with affected KPIs***
Business ethics	PLG04	Governance	Number of practices for ensuring ethical principles i.e., environmental responsibility, product quality and safety	Number of practices applied in a year	Corporate Behaviour	PLG02, PLS05	Transparency	ALL the processes of the investigated line	Yes	PSM Tool (Adherence to the ISO compliance - ISO16949 / Product Traceability *Connection with affected KPIs***
Customer acquisition	PLEG04	Economy & Growth	Number of new incoming customers per year	No	Customer	PLS05, PLS07, PLS09, PLS10	Resiliency	Quantitative from measurements/questionnaires	No	Constant Value in PSM (Questionnaire)
Customer retention	PLEG05	Economy & Growth	Perception of customers remaining or leaving, per year or specific period	% (±)	Customer	PLS05, PLS07, PLS09, PLS10	Economic advantage, Resiliency	Quantitative / from PSM after integrating actors	No	Constant Value in PSM (Questionnaire)
Revenue growth	PLEG09	Economy & Growth	Percentage of increase in revenues/sales generating income, for a specific time period	%	Growth perspective	PLE17, PLS03, PLES04, PLES02	Economic advantage	From PSM after integrating actors	Yes	PSM Tool, inserting the information for sales over a year
Usage of SRM (bonded NdFeb, Sr-Ferrite) in PM magnet pellets'	PLES02	Pilot Specific KPI	Percentage of SRM in PM magnet pellets' production	%	Pilot specific KPI	PLE06, PLE16, PLE17, PLE18	Circularity	*Processes included in actors IMDEA (Material Selection & Magnets Processing) and IMA* Bonded Magnet in Material Selection, Coated/ Contaminated, Demagnetizer, Magnet Crushing, Homogenizer,	Yes	PSM Tool (Calculation of production)

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for subcategory	Affected KPIs	Cause-and-effect Category	Connected Processes *Indicative*	KPI calculation from PSM	Type of calculation for visualisation
production (%)								Demagnetizer & Sand Blasting, Flash Milling & Furnace Treatment, Homogenizer (from Fr. Treatment), Homogenizer (Magnet Crushing), Extrusion Process with Polymer Blending, Injection, Magnetise, Magnet Breaking, Plastic Material Mixing, New Magnets Production		
Recycling from leftovers and disregarded magnets (%)	PLES04	Pilot Specific KPI	*Information/data from IMPDEA*	%	Pilot specific KPI	PLE06, PLE16, PLE17, PLE18	Circularity, Sustainability	*Processes included in actors IMDEA (Material Selection & Magnets Processing) and IMA* Bonded Magnet in Material Selection, Coated/ Contaminated, Demagnetizer, Magnet Crushing, Homogenizer, Demagnetizer & Sand Blasting, Flash Milling & Furnace Treatment, Homogenizer (from Fr. Treatment), Homogenizer (Magnet Crushing), Extrusion Process with Polymer Blending, Injection, Magnetise, Magnet Breaking, Plastic Material Mixing, New Magnets Production	Yes	PSM Tool (Calculation of production)

* *Depends on the case/ available data, usually in € per specific month, per specific area*

** *The connection with affected KPIs means that for the calculation/assessment of the value for this KPI, the affected KPIs will be utilised*

Table 5: Spanish Pilot Processes and Variables

Processes in ES Pilo0t	Actor Involved	Dependent Variable *Indicative*	Independent Variables – *Indicative*	Input of the process (in PSM) - *Indicative*	Output of the process (in PSM)- *Indicative*	Connected Processes (in the PSM Model) – *Indicative*	Connected KPIs - *Indicative*
Hazardous Elements Decontamination	Ferimet	NA - Manual Process/Linear Equation	NA - Manual Process/Linear Equation	Mass of WEEE	Mass of Hazardous elements that have been removed*, Massed of Exploitable material	Material Sorting	Electronic Waste, Scrap Waste, Resource Utilization, Transparency within the Supply Chain, Health and Safety, Revenue growth
Material Sorting	Ferimet	NA - Manual Process/Linear Equation	NA - Manual Process/Linear Equation	Mass of exploitable material	Mass of other elements that have been removed: plastic components, glass, etc., Mass of metallic exploitable material	Hazardous Elements Decontamination, Magnet Extraction	Electronic Waste, Scrap Waste, Resource Utilization, Transparency within the Supply Chain, Health and Safety, Revenue growth
Magnet Extraction	Ferimet	NA - Manual Process/Linear Equation	NA - Manual Process/Linear Equation	Mass of metalling exploitable material	Mass of recovered magnets (transported to IMDEA)	Material Sorting, Material Selection-Bonded Magnet	Electronic Waste, Scrap Waste, Resource Utilization, Health and Safety, Revenue growth, Transportation processes; Recycling from leftovers and disregarded magnets
Material Selection-Bonded Magnet	IMDEA – Material Selection	NA - Selection Process/Linear Equation	NA - Manual Process/Linear Equation	Mass of recovered magnets (from Ferimet)	Mass of bonded magnets (Sr-Ferrite & NdFeB)	Magnet Extraction, Demagnetiser (Sr-Ferite & NdFeB Magnets)	Carbon Dioxide (CO_2), Energy consumption, Resource Utilization, Transportation processes, Transparency within the Supply Chain, Business Ethics,
Material Selection – Coated/Contaminated Magnet	IMDEA – Material Selection	NA - Selection Process/Linear Equation	NA - Manual Process/Linear Equation	Mass of recovered magnets *minus* Mass of bonded magents	Mass of non-contaminated magnets (Sintered Sr-Ferite)	Magnet Extraction, Demagnetiser & Sand Blasting (Sr-Ferite & NdFeB Magnets)	Carbon Dioxide (CO_2), Energy consumption, Resource Utilization, Transportation processes, Transparency within the Supply Chain, Business Ethics
Material Selection – Coated/Contaminated Magnet *(other waste)*	IMDEA – Material Selection	NA - Selection Process/Linear Equation	NA - Manual Process/Linear Equation	Mass of recovered magnets *minus* Mass of bonded magents	Mass of contaminated/coated magnets *(other waste)* - ***final product***	Magnet Extraction, Demagnetiser & Sand Blasting (Sr-Ferite & NdFeB Magnets)	Carbon Dioxide (CO_2), Energy consumption, Resource Utilization, Transportation, Transparency within the Supply Chain processes, Scrap Waste, Business Ethics
Demagnetiser (Sr-Ferite & NdFeB Magnets)	IMDEA – Magnets Processing	Mass of Demagnetised Magnets (Sr-Ferrite & NdFeB)	Temperature of demagnetising	Mass of bonded magnets (Sr-Ferrite & NdFeB)	Mass of Demagnetised Magnets (Sr-Ferrite & NdFeB)	Material Selection-Bonded Magnet, Magnet Crushing (Sr-Ferite & NdFeB Magnets)	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics
Demagnetiser & Sand Blasting (Sr-Ferite & NdFeB Magnets)	IMDEA – Magnets Processing	Mass of Demagnetised Magnets (Sintered Sr-Ferite)	Temperature of demagnetising, *and variables in relevance to the sand blasting* *To be concluded when the flowchart is finalised*	Mass of non-contaminated magnets (Sintered Sr-Ferite)	Mass of Demagnetised Magnets (Sintered Sr-Ferite)	Material Selection – Coated/Contaminated Magnet, Magnet Crushing (Sintered Sr-Ferite)	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics

Processes in ES Pilo0t	Actor Involved	Dependent Variable *Indicative*	Independent Variables – *Indicative*	Input of the process (in PSM) - *Indicative*	Output of the process (in PSM)- *Indicative*	Connected Processes (in the PSM Model) – *Indicative*	Connected KPIs - *Indicative*
Magnet Crushing (Sr-Ferite & NdFeB Magnets)	IMDEA – Magnets Processing	Massed of crushed magnets (Sr-Ferrite & NdFeB)	Time of crushing, Speed of crushing (RPM) (Sr-Ferite & NdFeB Magnets)	Mass of Demagnetised Magnets (Sr-Ferrite & NdFeB)	Massed of crushed magnets (Sr-Ferrite & NdFeB)	Demagnetiser (Sr-Ferite & NdFeB Magnets), Homogenizer (Sr-Ferite & NdFeB Magnets)	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics, Usage of SRM (bonded NdFeb, Sr-Ferrite) in PM magnet pellets' production
Magnet Crushing (Sintered Sr-Ferite)	IMDEA – Magnets Processing	Massed of crushed magnets (Sintered Sr-Ferite) *to homogeniser*	Time of crushing, Speed of crushing (RPM) (Sintered Sr-Ferite)	Mass of Demagnetised Magnets (Sintered Sr-Ferite)	Massed of crushed magnets (Sintered Sr-Ferite) *to homogeniser*	Demagnetiser & Sand Blasting (Sr-Ferite & NdFeB Magnets), Flash Milling &furnace treatment, Homogenizer (Sintered Sr-Ferite)	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics, Usage of SRM (bonded NdFeb, Sr-Ferrite) in PM magnet pellets' production
Magnet Crushing (Sintered Sr-Ferite) – Milling & furnace treatment	IMDEA – Magnets Processing	Massed of crushed magnets (Sintered Sr-Ferite) *to milling & furnace treatment*	Time of milling, Speed of milling (RPM)	Massed of crushed magnets (Sintered Sr-Ferite)	Massed of crushed magnets/Magnetic Powder (Sintered Sr-Ferite) *to milling & furnace treatment*	Demagnetiser & Sand Blasting (Sr-Ferite & NdFeB Magnets), Flash Milling &furnace treatment	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics, Usage of SRM (bonded NdFeb, Sr-Ferrite) in PM magnet pellets' production
Flash Milling &furnace treatment	IMDEA – Magnets Processing	Mass of magnets from furnace treatment	Time of flash milling, Speed of slash milling (RPM)	Massed of crushed magnets (Sintered Sr-Ferite) *to milling & furnace treatment*	Mass of magnets from furnace treatment/ Magnetic powder	Magnet Crushing (Sintered Sr-Ferite), Homogenizer (Sintered Sr-Ferite)	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics
Homogenizer (Sr-Ferite & NdFeB Magnets)	IMDEA – Magnets Processing	Mass of homogenised magnets 1	*To be defined after the verification of the final model of PSM*	Massed of crushed magnets (Sr-Ferrite & NdFeB)	Mass of homogenised magnets 1	Extrusion Process with Polymer Blending, Magnet Crushing (Sr-Ferite & NdFeB Magnets)	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics
Homogenizer (Sintered Sr-Ferite)	IMDEA – Magnets Processing	Mass of homogenised magnets 2	*To be defined after the verification of the final model of PSM*	Massed of crushed magnets (Sintered Sr-Ferite)	Mass of homogenised magnets 2	Extrusion Process with Polymer Blending, Magnet Crushing (Sintered Sr-Ferite)	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics
Homogenizer (Sintered Sr-Ferite)– Milling & furnace treatment	IMDEA – Magnets Processing	Mass of homogenised magnets 3	*To be defined after the verification of the final model of PSM*	Massed of crushed magnets/Magnetic Powder (Sintered Sr-Ferite) *to milling & furnace treatment*	Mass of homogenised magnets 3	Extrusion Process with Polymer Blending, Magnet Crushing (Sintered Sr-Ferite) – Milling & furnace treatment	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics
Extrusion Process with Polymer Blending	IMDEA – Magnets Processing	Mass of polymer blending magnets	*To be defined after the verification of the final model of PSM*	Mass of homogenised magnets 1, 2 & 3	Mass of polymer blending magnets	Microstructural, Morphological & Magnetic Testing, Magnet Crushing (Sintered Sr-Ferite) – Milling & furnace treatment, Magnet Crushing (Sr-Ferite & NdFeB Magnets), Magnet	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics; Consumption of virgin raw materials, Usage of SRM (bonded NdFeb, Sr-Ferrite) in PM magnet pellets' production

Processes in ES Pilo0t	Actor Involved	Dependent Variable *Indicative*	Independent Variables – *Indicative*	Input of the process (in PSM) - *Indicative*	Output of the process (in PSM)- *Indicative*	Connected Processes (in the PSM Model) – *Indicative*	Connected KPIs - *Indicative*
						Crushing (Sintered Sr-Ferite)	
Microstructural, Morphological & Magnetic Testing	IMDEA – Magnets Processing	NA/No manufacturing process takes place – Linear equation	NA/No manufacturing process takes place – Linear equation	Mass of polymer blending magnets	Mass of polymer blending magnets – tested	Injection, Extrusion Process with Polymer Blending	Same as in *Extraction Process with Polymer Blending*
Injection	IMA	Mass of injected magnets	*To be defined after the verification of the final model of PSM*	Mass of polymer blending magnets – tested + Mass of mixed magnets *(from plastic material mixing)*	Mass of injected magnets	Magnetise, Quality Assurance	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics, Transportation processes, Green logistics
Magnetise	IMA	Mass of magnetised magnets	*To be defined after the verification of the final model of PSM*	Mass of injected magnets	Mass of magnetised magnets	Injection, Quality Assurance	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics; Consumption of virgin raw materials, Resource Utilization
Quality Assurance* *If necessary, the mass of magnetised magnets of this process goes back again to injection process*	IMA	NA/No manufacturing process takes place – Linear equation	NA/No manufacturing process takes place – Linear equation	Mass of magnetised magnets	Mass of magnetised magnets - checked	Magnetise, New Magnets Production	Same as in *Magnetise*
Magnet Breaking	IMA	Mass of broken magnets	Pressure, Time of breaking	Mass of magnet pellets from IMA	Mass of broken magnets	Plastic Material Mixing	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics;
Plastic Material Mixing	IMA	Mass of mixed magnets	Speed of mixing, Amount of plastic	Mass of broken magnets	Mass of mixed magnets	Magnet Breaking, New Magnets Production	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics; Consumption of virgin raw materials, Resource Utilization
New Magnets Production	IMA	NA/No manufacturing process takes place – Linear equation	NA/No manufacturing process takes place – Linear equation	Mass of magnetised magnets - checked	Mass of new magnets produced – **final product**	Quality Assurance	Carbon Dioxide (CO_2), Energy consumption, Product safety and quality, Transparency within the Supply Chain, Business Ethics; Consumption of virgin raw materials, Resource Utilization, Recycling from leftovers and disregarded magnets

**Hazardous elements can include mercury, lead, cadmium, and other that can be found in batteries, placing casings and cables, cooling agents, insulation foams, etc.*

3.3 CFRP Waste for Drones

Concluding with the Plooto use cases, the last one is located in Italy and investigates recycling and reusability of Carbon Fiber Reinforced Polymer-CFRP Waste for Drones. In Plooto, this use case is characterised by high intervention complexity, since it involves a group of interconnected processes from four different companies/project partners that deploy an intricate value chain. HCP, CETMA, CC and ACCELI, are key stakeholders of this interdependent value chain, which mainly focuses on recycling and requalification procedures for expired prepreg rolls and uncured scraps. The lack of traceability (critical tracing information relevant to the material origin, the history and previous usage) is one of the main challenges in this case, as reported in D1.1. Considering the complexity and variety of operations across the value chain, and the actors involved, the flowchart of this pilot is quite intricate (Figure 7), therefore, the KPIs for SBSC have been retrieved according to the preferences and needs of the overall value chain and involved actors.

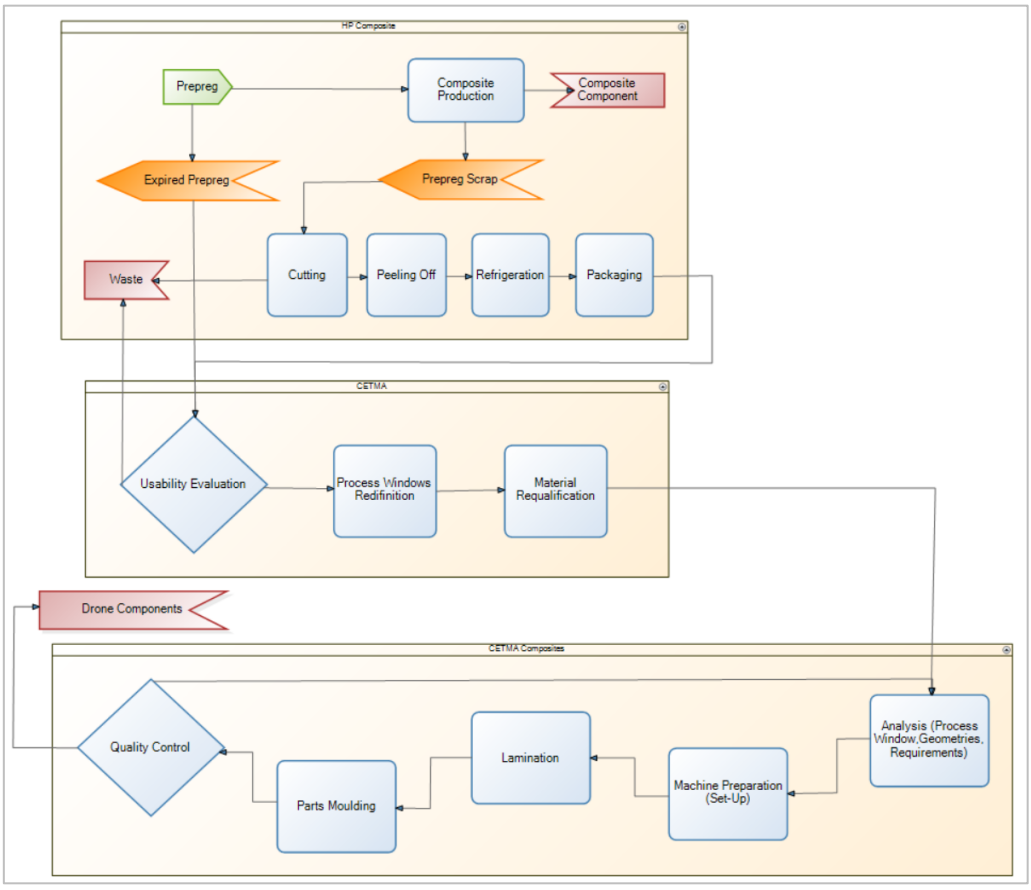

Figure 7: Italian Pilot Flowchart - *CFRP Waste for Drones*
(retrieved from D2.3 Process Modelling and Simulation Service)

Similarly to the Plooto use cases presented above, Table 6 presents all the critical information and data for structuring the SBSC of the CFRP Waste for Drones. Given the fact that the flowchart and the involved processes of this pilot have not been finalised yet and some updates are expected to take place, Table 7 presents the indicative processes and variables. **At this point, the model of the CFRP production line is to be defined. Therefore, all relevant information regarding the processes is indicative, and this is noted on Table 6 & Table 7, where necessary.**

Table 6: Italian Pilot KPIs – *CFRP Waste for Magnets*

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for category	Affected KPIs	Cause-and-effect Category	Connected Processes	Type of calculation for visualisation
Carbon Dioxide (CO_2)	PLE01	Environment	Amount of CO_2 released from the activities across the supply chain	kgeq	Carbon footprint	PLE02, PLE06, PLE09, PLE10, PLE12, PLE19, PLE20, PLIT02, PLIT05	Sustainability	Composite production, Prepreg scrap, Cutting, Peeling off, Refrigeration, Packaging, Process Windows Redefinition, Material Requalification, Analysis, Machine Preparation (Set-up), Lamination, Parts Moulding	PSM Tool
Energy consumption	PLE06	Environment	Amount of energy consumed across the supply chain	kWh	Resources	PLE01, PLE07, PLE09, PLE10, PLE19, PLE20	Sustainability		PSM Tool
Use of RES/RES integration	PLE07	Environment	Amount of energy produced by RES	kWh	LCA/Resources	PLE01, PLE06, PLE20	Sustainability, Resiliency		PSM Tool
Transportation processes	PLE09	Environment	Consumptions related to the transportation/logistics (i.e., energy)	DOC	Resources	PLE01, PLE06, PLE10	Sustainability	Packaging, Usability Evaluation, Waste, Material Requalification, Quality Control	PSM Tool (By calculating the consumed energy/resources for the transportation needs) *Connection with affected KPIs**
Green logistics	PLE10	Environment	Amount of emissions during logistics activities (warehousing and transportation)	kg	Resources	PLE01, PLE06, PLE09	Sustainability, Resiliency	Packaging, Usability Evaluation, Waste, Material Requalification, Quality Control	PSM Tool (By calculating the emissions related to the consumed energy/resources for the transportation needs) *Connection with affected KPIs**
Recycling rates	PLE12	Environment	Amount of recycled plastics or recycled materials	kg	Pollution and Waste	PLE01, PLE06, PLE14, PLE18, PLE20, PLG03, PLG05, PLEG04, PLEG09	Circularity	Prepreg, Expired prepreg, Composite production, Prepreg scrap, Cutting, Peeling off, Refrigeration, Packaging, Usability Evaluation	PSM Tool (By calculating the amounts that are related to the recycling material) *Connection with affected KPIs**
Packaging materials and waste	PLE14	Environment	Amount of waste from packaging material	kg	Pollution and Waste	PLE01, PLE16	Sustainability	Packaging, Usability Evaluation, Drone Components	PSM Tool PSM Tool (By calculating the amount of waste and considering the information about packaging materials)
Scrap Waste	PLE16	Environment	Amount of scrap waste	kg	Pollution and Waste	PLE01, PLE18, PLG02, PLG04	Sustainability	Prepreg, Expired prepreg, Composite production, Prepreg scrap, Cutting, Peeling off, Refrigeration, Packaging, Usability Evaluation, Waste	PSM Tool (Calculating the amount of scrap waste from the related to scrap production processes)

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for category	Affected KPIs	Cause-and-effect Category	Connected Processes	Type of calculation for visualisation
Consumption of virgin raw materials	PLE18	Environment	Amount of virgin raw material consumed	kg	Resources	PLE01, PLE20, PLS07	Sustainability, Resiliency, Circularity	All processes	PSM Tool (Constant value provided by the pilot partners)
ISO22400 for traditional manufacturing	PLE19	Environment	ISO Certification that the company/industry meets the certification standards	-	Opportunities and Innovation	PLE01, PLE02, PLE20, PLS01, PLS05, PLS09, PLG02, PLEG04	Sustainability, Resiliency, Transparency	All processes	PSM Tool PSM Tool (Checking the operational parameters) *Connection with affected KPIs**
ISO59020 for measuring and assessing circularity	PLE20	Environment	ISO Certification that the company/industry meets the certification standards	-	Opportunities and Innovation	PLE01, PLE06, PLE07, PLE10, PLE12, PLE14, PLE16, PLE18, PLS09, PLS10, PLG02, PLG04, PLEG03, PLEG04, PLEG05	Circularity	All processes	PSM Tool PSM Tool (Checking the operational parameters) *Connection with affected KPIs**
Health and Safety	PLS01	Society	Assessment health and safety conditions in the industrial company	Qualitative	Human Capital	PLE19, PLS14	Resiliency	Qualitative from measurements/questionnaires	Constant Value in PSM (Questionnaire) *Connection with affected KPIs**
Training and Staff development	PLS03	Society	Availability and implementation of training programs and staff development activities	No. of training	Human Capital	PLE19, PLEG08	Resiliency	Quantitative from measurements/questionnaires	Constant Value in PSM (Questionnaire)
Product safety and quality	PLS05	Society	The industrial company meets the standards for product safety and quality	Qualitative	Product Assessment	PLE19, PLE20	Resiliency, Traceability	Qualitative from measurements/questionnaires	Constant Value in PSM (By setting a threshold/ Characteristic value, and its performance) *Connection with affected KPIs**
Transparency within the Supply Chain	PLS07	Society	The level of transparency regarding the quality and origin of the materials, the processing, etc.	Qualitative	Product Assessment	All	Transparency	All processes	PSM Tool (By inserting information about origin & quality of material, and the quality of operational processes)
Supply Chain Liability	PLS09	Society	The legal responsibility of the industrial company for actions or shortcomings across its supply chain	Qualitative	Stakeholders	PLS07, PLE19, PLE20, PLG02, PLG04	Transparency, Traceability	All processes	PSM Tool (Constant value, according to industry's compliance with national regulations)

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for category	Affected KPIs	Cause-and-effect Category	Connected Processes	Type of calculation for visualisation
Customer satisfaction	PLS10	Society	Level of satisfaction of costumers from the product use	Qualitative	Stakeholders	PLS05, PLS07, PLS09, PLEG04, PLEG05	Resiliency	Qualitative from measurements/questionnaires	Constant Value in PSM (Questionnaire) *Connection with affected KPIs**
Employee satisfaction	PLS11	Society	Level of satisfaction of employees in the company	Qualitative	Human Capital	PLS01, PLS03	Resiliency	Qualitative from measurements/questionnaires	Constant Value in PSM (Questionnaire)
Work-Life Balance	PLS14	Society	Level of balance between professional responsibilities and personal time	Qualitative	Opportunities	PLG04, PLE19, PLS05	Resiliency	From PSM	PSM Tool (Considering the working hours per shift (e.g. 8h per 5days))
Anti-competitive practices	PLG02	Governance	Number of practices that an industrial company follows to gain an advantage in the market (i.e., price fixing, bid rigging, market allocation, etc.)	Number of practices applies in a year	Corporate Behaviour	PLG04, PLE19, PLS05	Transparency	All processes	PSM Tool (Numbering the practices) *Connection with affected KPIs**
Business ethics	PLG04	Governance	Number of practices for ensuring ethical principles i.e., environmental responsibility, product quality and safety	Number of practices applied in a year	Corporate Behaviour	PLG02	Transparency	All processes	PSM Tool (Adherence to the ISO compliance - ISO22400 / Product Traceability *Connection with affected KPIs**
Market share	PLEG01	Economy & Growth	The percentage of sales of a product related to all sales of that product for a specific time period i.e., per month, and for a specific geographic area (i.e., at national level)	Depends on the case*	Finance	PLS10, PLEG04, PLEG05, PLEG08, PLIT02	Economic Advantage	Quantitative from measurements	PSM Tool (Assessing percentage in relevance to production for prepreg)
Net cost savings due to circular activities	PLEG03	Economy & Growth	Assessment of savings that coming from circular activities (i.e., re-use of materials or secondary raw materials, treatment of water to enter the process, etc.)	€	Finance	PLIT05, PLE12, PLIT02	Economic Advantage, Circularity	Prepreg, Expired prepreg, Composite production, Prepreg scrap, Cutting, Peeling off, Refrigeration, Packaging, Usability Evaluation, Waste	PSM Tool (Assessing incomes in relevance to production)
Customer acquisition	PLEG04	Economy & Growth	Number of new incoming customers per year	No	Customer	PLS05, PLS07, PLS09, PLS10	Resiliency	Quantitative from measurements/questionnaires	Constant Value in PSM (Questionnaire)
Customer retention	PLEG05	Economy & Growth	Perception of customers remaining or leaving, per year or specific period	% (±)	Customer	PLS05, PLS07, PLS09, PLS10	Economic advantage, Resiliency	Quantitative from measurements/questionnaires	Constant Value in PSM (Questionnaire)
Productivity growth	PLEG08	Economy & Growth	Percentage of increase in output/value generated per unit, for a specific time period	%	Growth perspective	PLS03, PLEG05, PLEG04	Economic Advantage	From PSM after integrating actors	PSM Tool (Assessing in relevance to PLS03, PLEG04 & 05)

KPI Name	KPI Code in Plooto	KPI Category	Description	Unit	Eligible for category	Affected KPIs	Cause-and-effect Category	Connected Processes	Type of calculation for visualisation
									*Connection with affected KPIs**
Revenue growth	PLEG09	Economy & Growth	Percentage of increase in revenues/sales generating income, for a specific time period	%	Growth perspective	PLS03, PLS05, PLEG03	Economic Advantage	From PSM after integrating actors	PSM Tool, inserting the information for sales over a year
Prepreg disposal in HP	PLIT02	Pilot Specific KPI	Amount of discarding uncured or expired prepreg waste that generated in the industry	tons/year	Pilot Specific KPI	PLE12, PLE16, PLE18, PLS05, PLG04, PLEG03, PLEG09	Pilot Specific	All processes	PSM Tool (Calculation of production)
Unused CFRP waste in the production of composite materials (%)	PLIT05	Pilot Specific KPI	Increase in the use of CFRP waste in the production of composite materials due to reuse	%	Pilots Specific KPI	PLE12, PLE16, PLE18, PLS05, PLEG03, PLEG09	Pilot Specific	All processes	PSM Tool (Calculation of production)

**The connection with affected KPIs means that for the calculation/assessment of the value for this KPI, the affected KPIs will be utilised*

Table 7: Italian Pilot Processes and Variables

Processes in IT Pilo0t	Actor(s) Involved	Dependent Variable *Indicative*	Independent Variables – *Indicative*	Input of the process (in PSM) - *Indicative*	Output of the process (in PSM)- *Indicative*	Connected Processes (in the PSM Model) – *Indicative*	Connected KPIs - *Indicative*
Prepreg	HPC	Mass of prepreg / Input data provided by the pilot	Temperature, Pressure	Mass of prepreg	Mass of prepreg to composite production	Expired prepreg, Composite Production	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics
Expired prepreg	HPC	Mass of material recovered/reused	*To be concluded after the flowchart finalisation*	Mass of prepreg	Mass of material recovered/reused	Prepreg, Usability Evaluation	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics, Transportation processes, Green logistics, recycling rates
Composite production	HPC	Mass of composite produced	Mass of prepreg, Time of cure, Temperature of cure, Pressure	Mass of prepreg to composite production	Mass of composite produced	Prepreg, Composite component, Prepreg scrap	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics
Composite component	HPC	Mass of composite component (final product)/Percentage of components meeting quality standards	*Process control measures To be concluded after the flowchart finalisation*	Mass of composite produced	Mass of composite component (final product)	Composite production	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics

Processes in IT Pilo0t	Actor(s) Involved	Dependent Variable *Indicative*	Independent Variables – *Indicative*	Input of the process (in PSM) - *Indicative*	Output of the process (in PSM)- *Indicative*	Connected Processes (in the PSM Model) – *Indicative*	Connected KPIs - *Indicative*
Prepreg scrap	HPC	Mass of scrap reused or recycled	*Scrap quantity and type To be concluded after the flowchart finalisation*	Mass of composite produced	Mass of scrap reused or recycled	Composite production, Cutting	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics
Cutting (to peeling node)	HPC	Mass of cut prepreg	Material yield, Cutting Speed, Cutting Efficiency	Mass of scrap reused or recycled	Mass of cut prepreg	Prepreg scrap, peeling off	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics, Scrap Waste
Cutting (to waste node)	HPC	Mass of waste	Material yield, Cutting Speed, Cutting Efficiency	Mass of scrap reused or recycled	Mass of waste (waste to be disposed, final process)	Prepreg scrap, waste	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics
Peeling off	HPC	Mass of peeled prepreg	Time of peeling, Peeling Efficiency, Amount of waste generated of peeling process	Mass of cut prepreg	Mass of peeled prepreg	Cutting, Refrigeration	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics
Refrigeration	HPC	Mass of refrigerated prepreg	Time of the process, Temperature, Humidity	Mass of peeled prepreg	Mass of refrigerated prepreg	Peeling off, packaging	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics
Packaging	HPC	Mass of prepreg packed and transferred to CETMA	Packaging time, packaging materials, packaging waste	Mass of refrigerated prepreg	Mass of prepreg packed and transferred to CETMA	Refrigeration, Usability Evaluation,	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics, Scrap Waste, Packaging and materials waste, Transportation processes, green logistics, Prepreg disposal in HP
Waste	HPC	NA *A mass balance equation to be used for this process*	NA *A mass balance equation to be used for this process*	Mass of waste (waste to be disposed, final process) from cutting node ***plus*** Mass of waste that returns to HP after CETMA usability evaluation	Total amount of waste prepreg	Cutting, Usability Evaluation	ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics, Scrap Waste, Anti-Competitive practices, Recycling Rates, ISO59020 for measuring and assessing circularity, Prepreg disposal in HP, Unused CFRP waste in the production of composite materials (%)
Usability Evaluation	HPC, CETMA	NA *The process involves evaluation activities – a constant value will be given as data from CETMA*	NA *The process involves evaluation activities – a constant value will be given as data from CETMA*	Mass of material recovered/reused ***plus*** Mass of prepreg packed and transferred to CETMA	Amount of usable/exploitable prepreg	Expired prepreg (HP Composite), Packaging	Scrap waste, Product Safety and Quality, Transparency within the supply chain, supply chain Liability, Recycling Rates, ISO59020 for measuring and assessing circularity, Net cost savings due to circular activities, Prepreg disposal in HP, Unused CFRP waste in the production of composite materials (%)
Process Windows Redefinition	CETMA	Amount of usable/exploitable prepreg/Amount of material that meets	Temperature of redefinition, Pressure of redefinition, Time of redefinition	Amount of usable/exploitable prepreg	Amount of redefined prepreg	Usability Evaluation, Material Requalification	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics

Processes in IT Pilo0t	Actor(s) Involved	Dependent Variable *Indicative*	Independent Variables – *Indicative*	Input of the process (in PSM) - *Indicative*	Output of the process (in PSM)- *Indicative*	Connected Processes (in the PSM Model) – *Indicative*	Connected KPIs - *Indicative*
		the original specifications					
Material Requalification	CETMA	Amount of requalified prepreg (that goes to CETMA Composites)	Temperature *and other process related variables To be concluded after the flowchart finalisation*	Amount of redefined prepreg	Amount of requalified prepreg (that goes to CETMA Composites)	Process Windows Redefinition, Analysis	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics
Analysis	CC	Amount of prepreg that has been analysed	Temperature, Pressure *and other process related variables To be concluded after the flowchart finalisation*	Amount of requalified prepreg (that goes to CETMA Composites)	Amount of prepreg that has been analysed	Material Requalification, Machine Preparation (Set-up)	ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics, ISO59020 for measuring and assessing circularity, Transportation processes, green logistics
Machine Preparation (Set-up)	CC	*To be defined after the flowchart finalisation*	*To be defined after the flowchart finalisation*	Amount of prepreg that has been analysed	Amount of prepreg goes for lamination	Analysis, Lamination	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics
Lamination	CC	Amount of laminated material	Temperature, Pressure, *and other process related variables To be concluded after the flowchart finalisation*	Amount of prepreg goes for lamination	Amount of laminated material	Machine Preparation (Set-up), Moulding	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics
Parts Moulding	CC	Amount of moulded material	Amount of raw material used for moulding, Temperature, Pressure *To be concluded after the flowchart finalisation*	Amount of laminated material	Amount of moulded material	Lamination, Quality Control	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics, Consumption of virgin raw materials
Quality Control *If considered necessary, amount of the moulded material goes back to the analyses process, to reenter this part of the chain*	CC	Amount of material produced (final product)	NA *The process involves evaluation activities – a constant value will be given as data from CETMA Composites*	Amount of moulded material	Amount of material that meets the quality requirements	Moulding, Drone Components, Analysis	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics, ISO59020 for measuring and assessing circularity
Drone Components (final product)	CC	Amount of final product	NA *The process involves evaluation activities – a constant value will be given as data from CETMA Composites*	Amount of material that meets the quality requirements	Amount of final product	Quality Control	Carbon Dioxide (CO_2), Energy Consumption, Use of RES/RES Integration, ISO22400, Product Safety and Quality, Transparency within the supply chain, Supply Chain Liability, Business Ethics, ISO59020 for measuring and assessing circularity, Net cost savings due to circular activities, Unused CFRP waste in the production of composite materials (%)

4 Building a one-stop-shop tool *(user documentation)*

The vision of the one-stop-shop tool in Plooto, is enhanced by the main objective of the project, which will facilitate manufacturers and industrial actors towards the pathway to their green, digital and circular transition. The Plooto Balanced Scorecard foresees to operate as a comprehensive source of critical information about the current use and potential reuse or recycling of materials, the current situation of the value chain, and potential improvements by assessing different KPIs, always considering the industries/pilots' preferences, needs and goals.

This section plays the role of the SBSC user documentation, describing and presenting step by step the actions for delivering the SBSC for each value chain of the Plooto use cases.

Inserting the .pmf file into the PSM Tool

The validated process modelling file (.pmf), which is exported by the PMS Tool, is selected and inserted into the PSM Suite (Figure 8). This file includes the models created under the Process Modelling and Simulation Service (D2.3) and are the digital representation of the value chain of each Plooto use case.

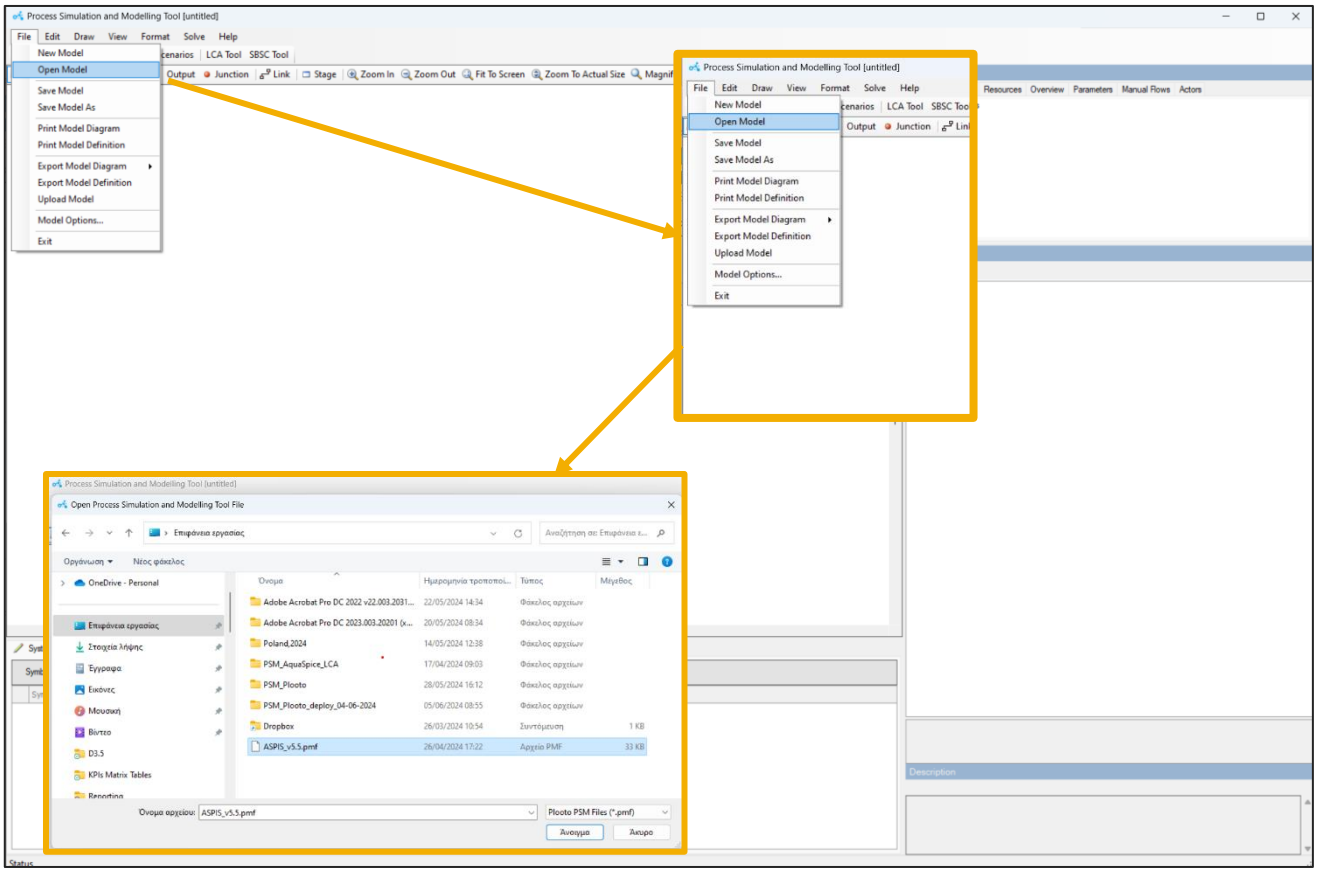

Figure 8: Inserting the model into the PSM

As described in the previous section, the model has been created by selecting the necessary equations for each process, indicating the dependent and independent variables, and enclosing the

cause-and-effect coefficients into the model's equations. To run this model, time-series of data are necessary and provided by the pilots (Figure 9).

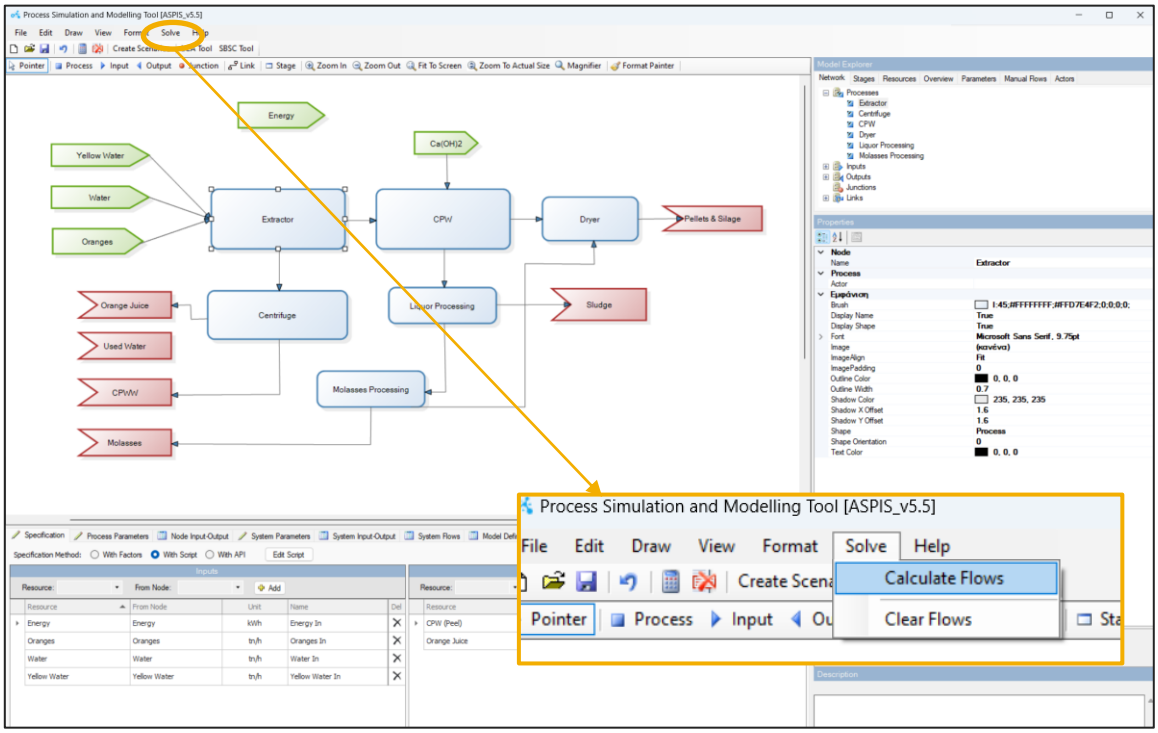

Figure 9: Calculating flows of process line of the Greek pilot

The SBSC has been built as an integrated module of the PSM Tool, which calculates the cause-and-effect coefficients, based on the KPIs selection and the pilots' needs for monitoring and assessing circularity and sustainability. After the flows and the system parameters calculation, the SBSC module is being selected (Figure 10).

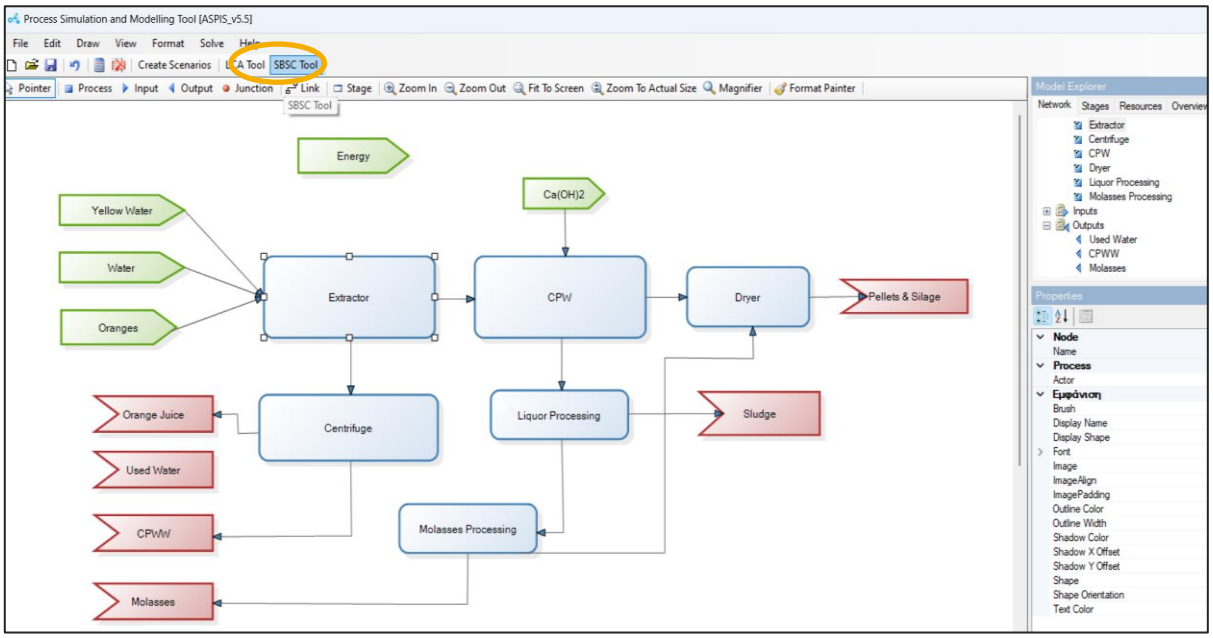

Figure 10: SBSC Module in the PSM Tool

The SBSC Module includes three dedicated tabs, the KPI Inventory, the Connected Processes, and the Cause-and-effect coefficients.

The **KPI Inventory** Tab, provides the opportunity for selection the targeted KPIs, according to the step 5 in the SBSC Implementation steps (Figure 2). The tab indicates the KPI name, the KPI Code in Plooto, the category that each KPI belongs, the measurement unit, and the checking box, where the user can select or deselect to enable or disable the KPI calculation, correspondingly (Figure 11).

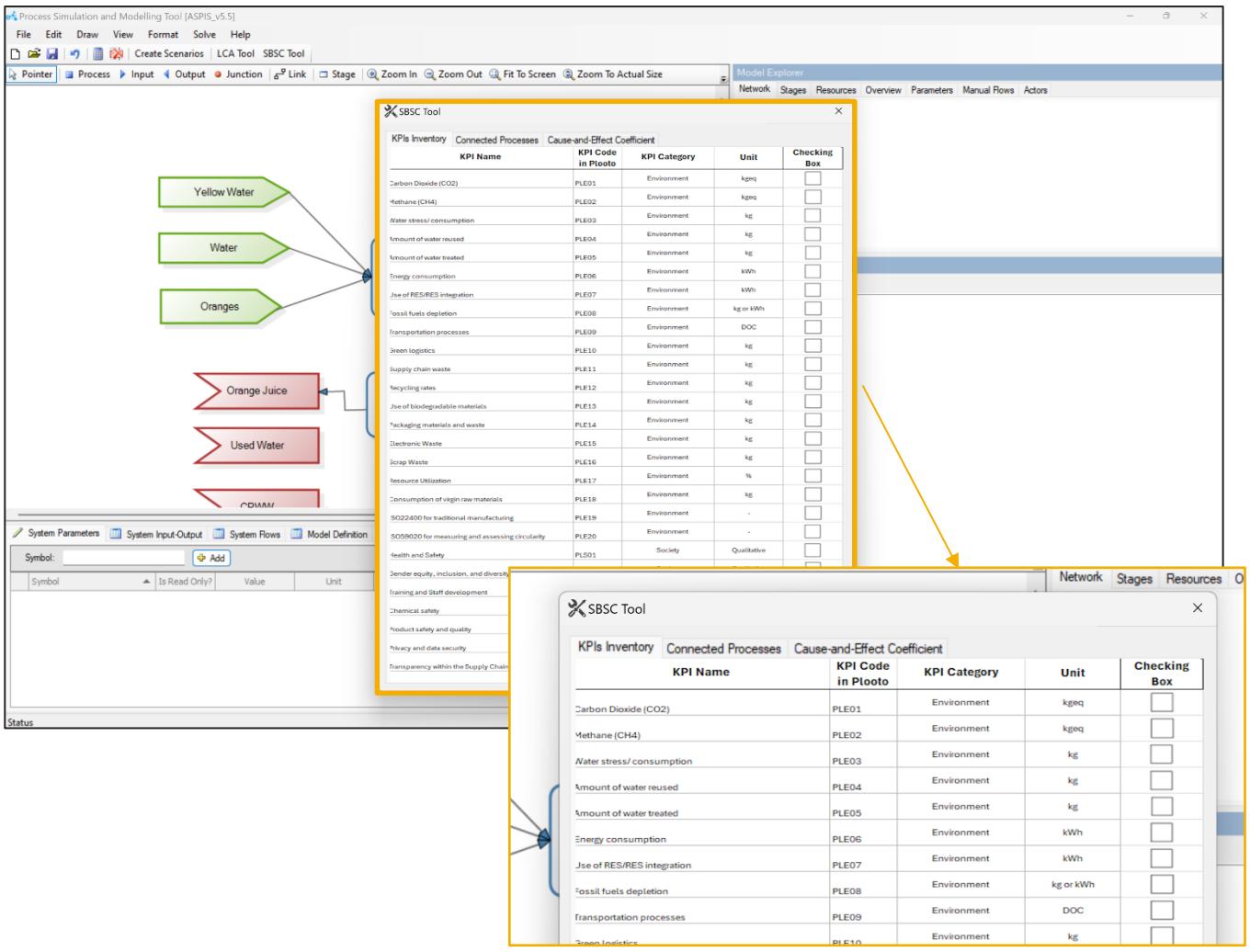

Figure 11: KPI Inventory Tab in the SBSC Tool

The ***Connected Processes Tab***, presents, according to the investigated model and the processes specifications, the processes that each KPI has a connection with, which are identified as the *connected processes of the KPI*. It also presents the affected KPIs, meaning the other KPI or KPIs, that are connected to these processes, and have a direct interdependency with the selected KPI.

Figure 12 showcases an indicative example, using the use case of the Greek Pilot (ASPIS). The KPIs have been selected from the pilot partners, who have indicated them as the representative indicators for assessing their main targets for circularity and sustainability within the industry. The first column presents the selected KPIs, following the inputs in the previous tab (KPIs inventory), also the code in Plooto project to facilitate the search-and-find of the KPIs. The connected processes

column presents, according to the developed model in PSM, the processes that the selected KPI can be found or is included. The affected KPIs column showcases the interdependency that each KPI has with another one of the selected list.

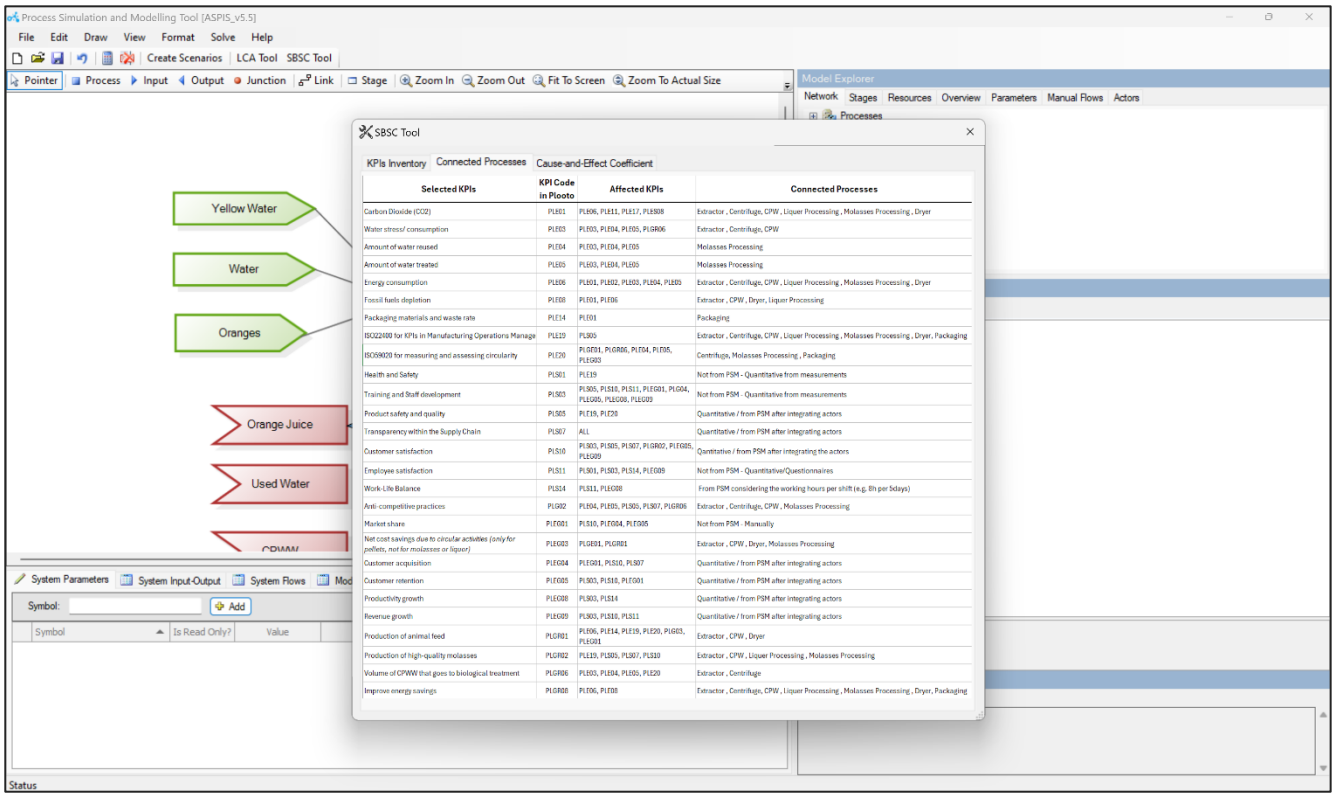

Figure 12: Connected Processes Tab in the SBSC Tool

For instance, in the example of the citrus processing industry, the Water consumption KPI (PLE03), is affecting the amount of water reused KPI (PLE04), the amount of water treated (PLE05) and the volume of CPWW that goes to biological treatment (PLGR06). The SBSC Tool, therefore, based on the processes as have been represented in the model, detects the connection of the KPIs across the processes, indicates the involved (connected) processes, and materialises this interdependency by calculating the cause-and-effect coefficients. These calculations will be showcased in the third tab, the ***Cause-and-effect coefficient*** (Figure 14).

The results of the SBSC assessment and their representation in the PSM will be included in the next and last version of the Plooto Balanced Scorecard deliverable (D3.6), along with the models and results of the Italian and the Spanish use cases.

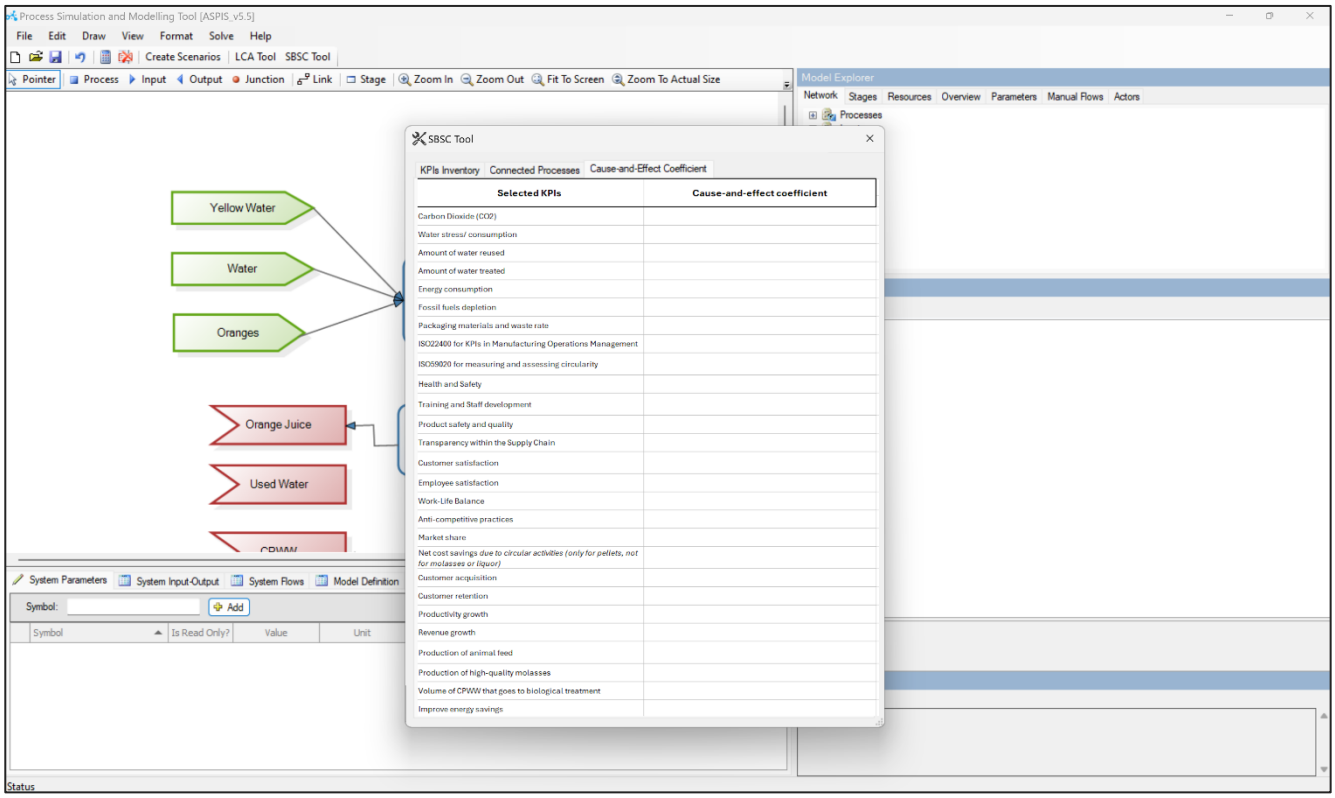

Figure 13: Cause-and-effect Coefficient Tab in the SBSC Tool

A wide range of different scenarios and alternatives investigated under the perspective of *what-if* analysis is available through the Plooto PSM Tool. By modifying the value of a selected parameter in the model, the resulted value of the cause-and-effect coefficient, can underline the level of importance of this modification, for example, which is the impact in the process line and all the connected KPIs, if we modify the temperature by 1°C in the neutrilisation reactor.

The integration of actors into the PSM backbone, as described and presented in D2.3, turns out to be a valuable and critical contribution, since the KPIs connected with the actors/stakeholders involved (e.g. of the *society category* or *economy and growth category*, as presented in Table 2, Table 4 and Table 6) can be inserted and/or calculated by the relevant connected components/processes.

Regarding the KPIs characterised as quantitative, and their calculation which occur through an alternative source (e.g. a questionnaire), the measured value (e.g., PLS01-Health and Safety KPI) can be inserted as a constant value in the PSM, in a *read only* mode, meaning that the value is inserted manually in the model, but is represented normally in the SBSC Module and its tabs, indicating its interconnection with the other KPIs. Figure 14 illustrates the updated PSM Model for the Greek use case, wherein the interconnected actors have been involved. Since in the Greek use case, the main actor is one industry, ASPIS, the actors represent the different group of processes, that an external stakeholder could have a direct interaction with, i.e. the buyer of the cattle feed produced by exploiting the citrus peels waste.

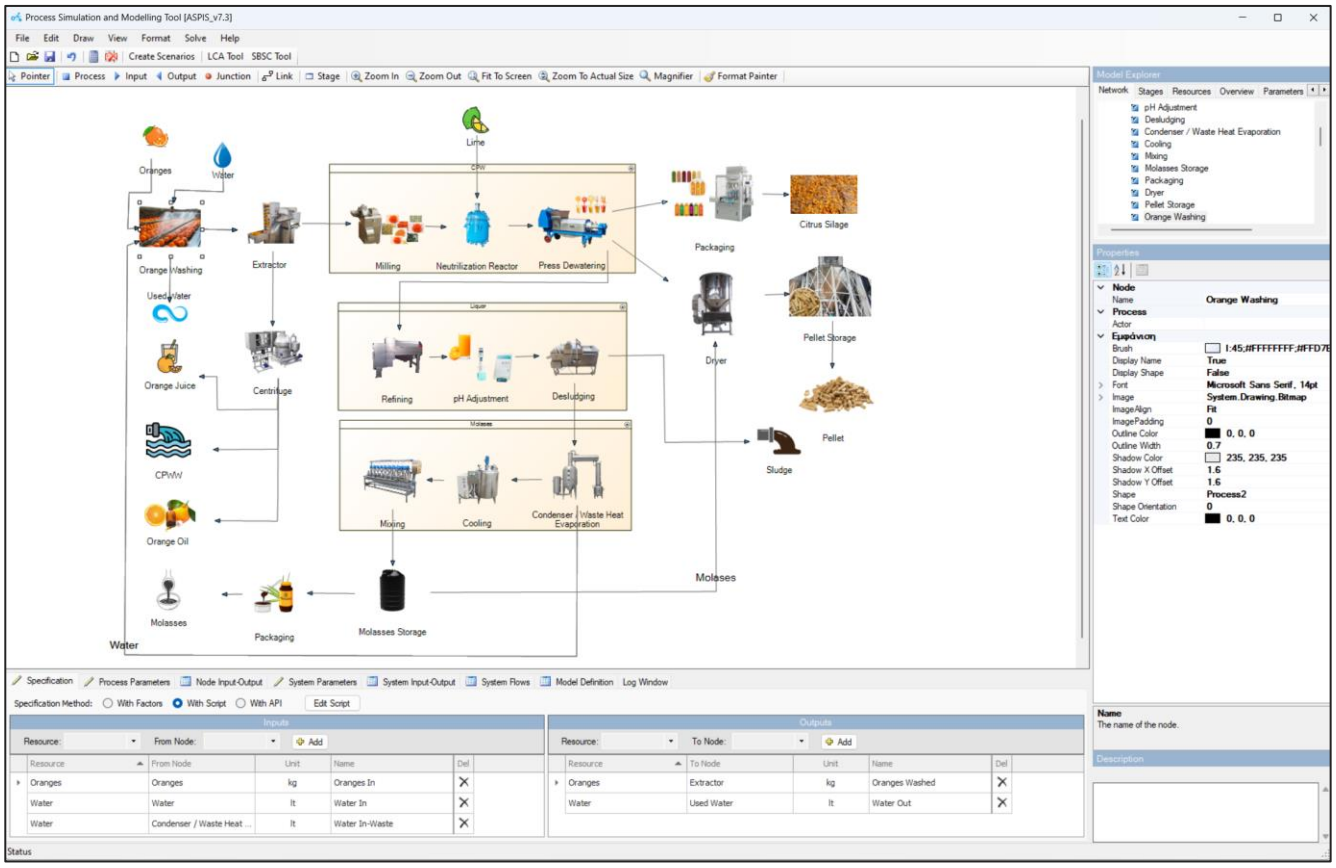

Figure 14: PSM Updated Model for ASPIS Pilot Use Case

The results that are calculated and presented in the *cause-and-effect coefficient* tab, are transmited through the generated API to the CRIS platform, as described in D2.3 and D3.3 with regards to the connectivity of Plooto services with the CRIS Platform.

The results are visualised to provide a direct information to the user about the circularity and sustainability across the value chain. The indicative visualisations are presented in the next chapter, having at the current time the characteristics of a mock-up. The final format of the visualisations will be provided in the second iteration of the Plooto Balanced Scorecard and the CRIS Platform.

5 Visualisation of Balanced Scorecards

The Plooto SBSC aspires to provide the interested parties with a comprehensive picture of their organization's performance that balances financial success with environmentally friendly approaches, social impact and a circular character. The SBSC as a tool/module intends to overcome the traditional metrics, moving beyond the financial and environmental results, by enclosing as well, the critical aspects of governance, society, and employees. By employing a combination of clear, concise and user-friendly elements such as dashboards, dynamic charts, and strategic heatmaps, the scorecard's design adopts a comprehensive understanding of the progress across the Plooto framework dimensions. This technical introduction emphasises the SBSC's ability to translate complex sustainability data into an actionable visual format, enabling organizations to effectively monitor and manage their sustainability efforts.

In Plooto project, the visualisation of all services is integrated and provided through the CRIS Platform. The overall approach is based on the configurable solutions that Plooto generates that are focused on the industries and model their value chains as a network of interconnected Digital Twins (DTs). The platform provides the opportunity to monitor/simulate the performance based on data for each individual asset.

The solution allows users to define their digital twins of 2 types:

- An individual asset (e.g., one process, a group of processes under the same department, etc)
- A network of assets (e.g., a supply chain, a group of supply chains, a value chain, etc)

The Dashboard of the Plooto Platform is customisable and configurable, creating an environment of interest and convenience for the user, according to his needs and perceptions. Customisation is enabled by adding or removing widgets (Figure 15 and Figure 16).

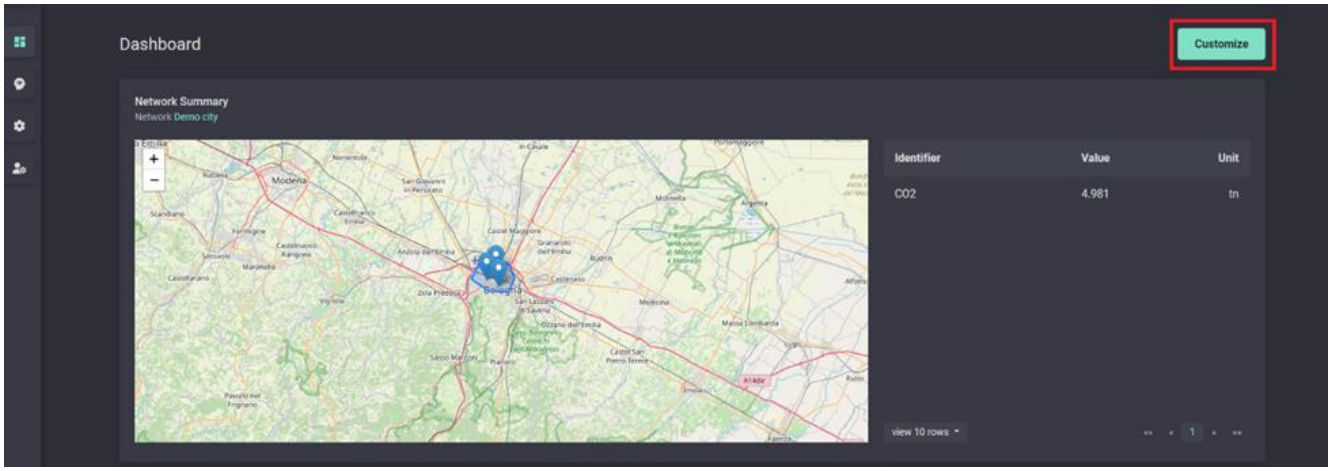

Figure 15: Plooto Dashboard

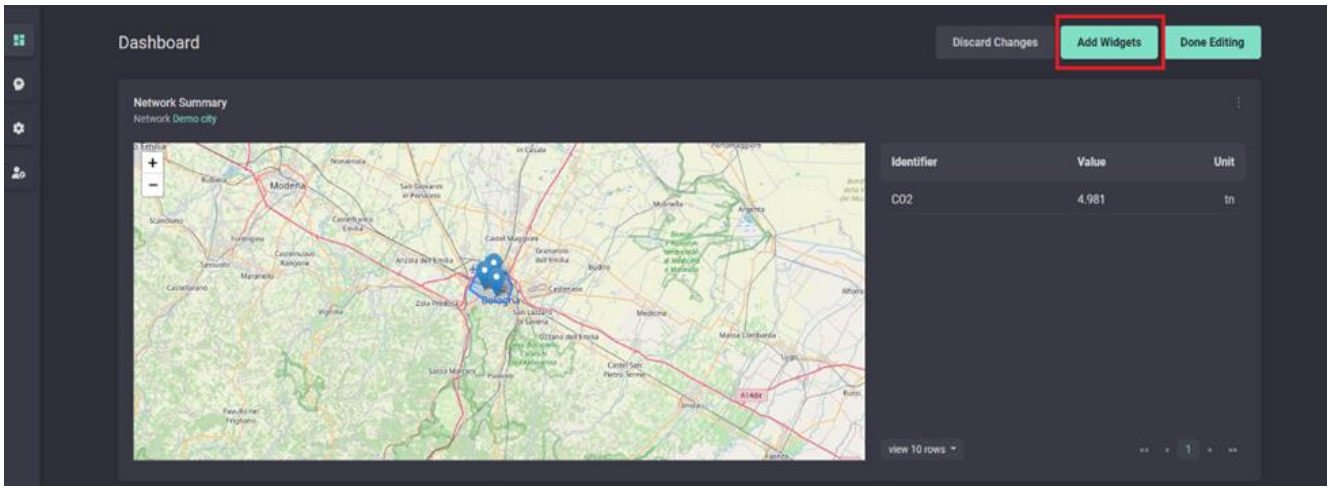

Figure 16: Customising the Plooto Dashboard

Plooto Dashboard adopts a configurable character that enables the opportunity to integrate APIs and add new Data Sources by importing JSON files (Figure 17 and Figure 18).

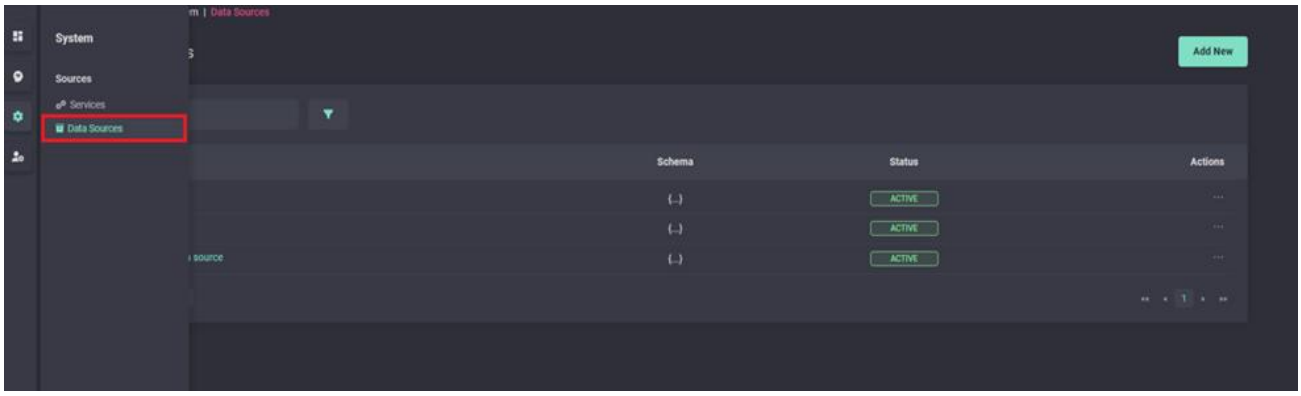

Figure 17: Data Sources option in Plooto Dashboard

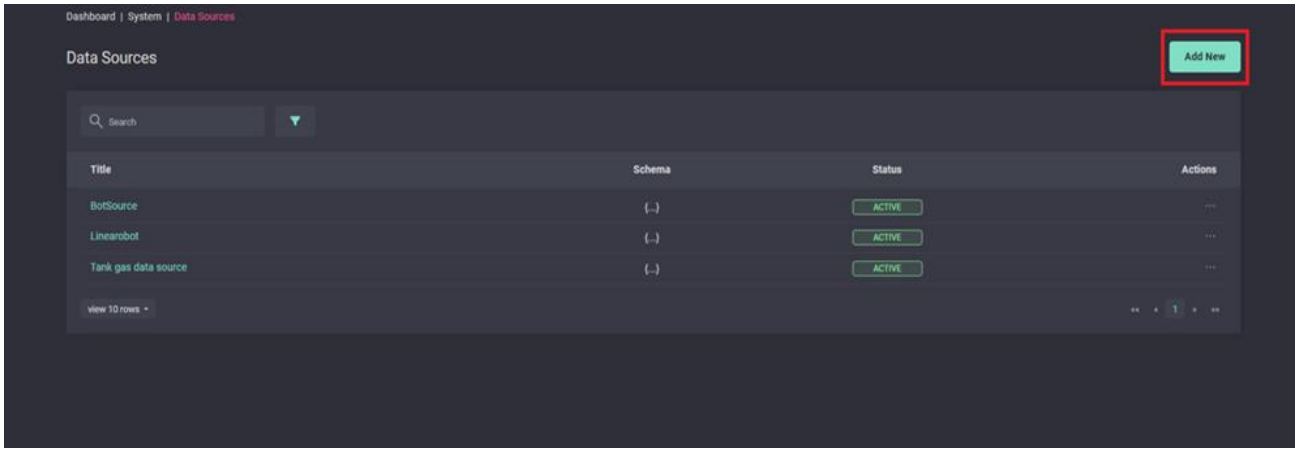

Figure 18: Adding New Data Source

In the case of the Plooto Scorecards, the PSM Tool uses the API for transferring the results of cause-and-effect coefficients calculation using a JSON format, to the Plooto Dashboard.

The Plooto Dashboard will be the mean of visualisation of the Plooto Scorecard, focusing on the main outcomes in terms of the SBSC main pillars: environment, society, governance, economy and growth, and industry related. These visualisations are presented in this deliverable under the format of mock-ups.

The first mock-up of the Plooto Scorecard will showcase the four main pillars/KPIs categories (environment, economy and growth, society, governance) and the investigated industry at each time. For the purposes of this first approach of visualisations, the Greek pilot has been used. Every circular element of the Figure 19 is an active element that opens a new visualisation that indicates the results of the overall performance of the industry under the selected pillar. Indicative examples of these visualisations are presented in the next figures (Figure 20 and Figure 21).

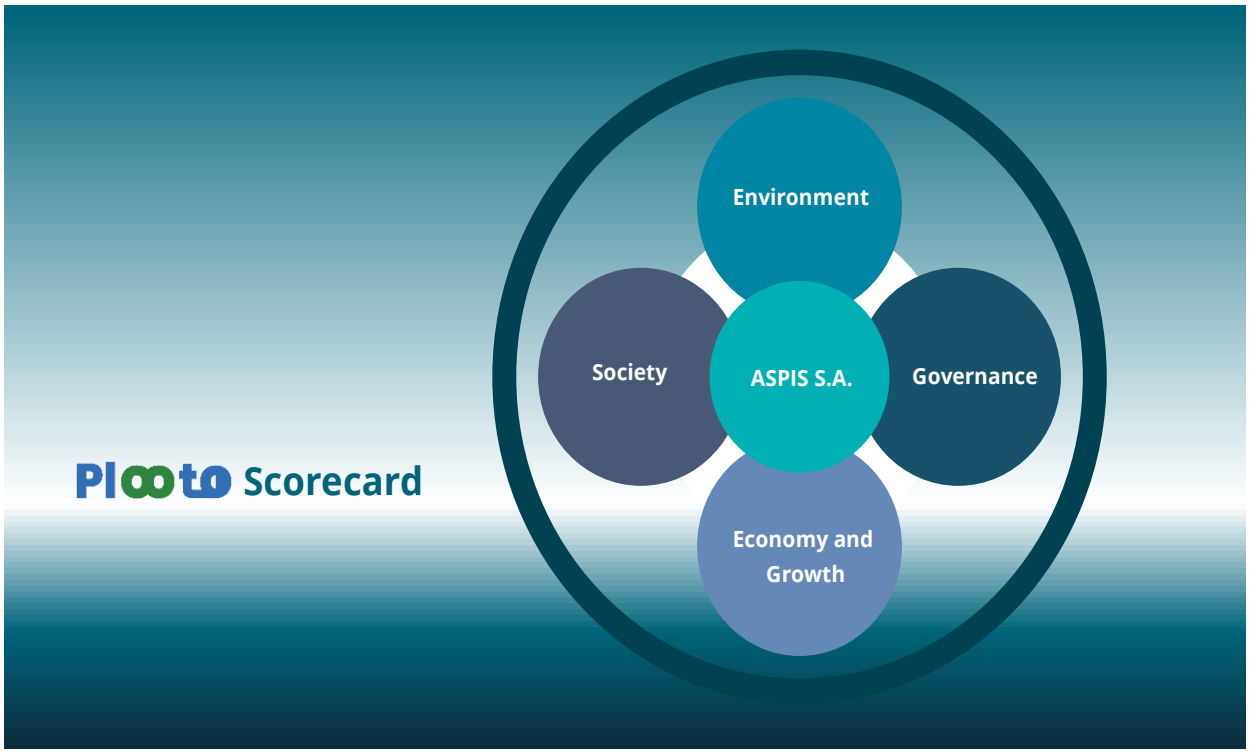

Figure 19: Mock-up of the Plooto Balanced Scorecard homepage

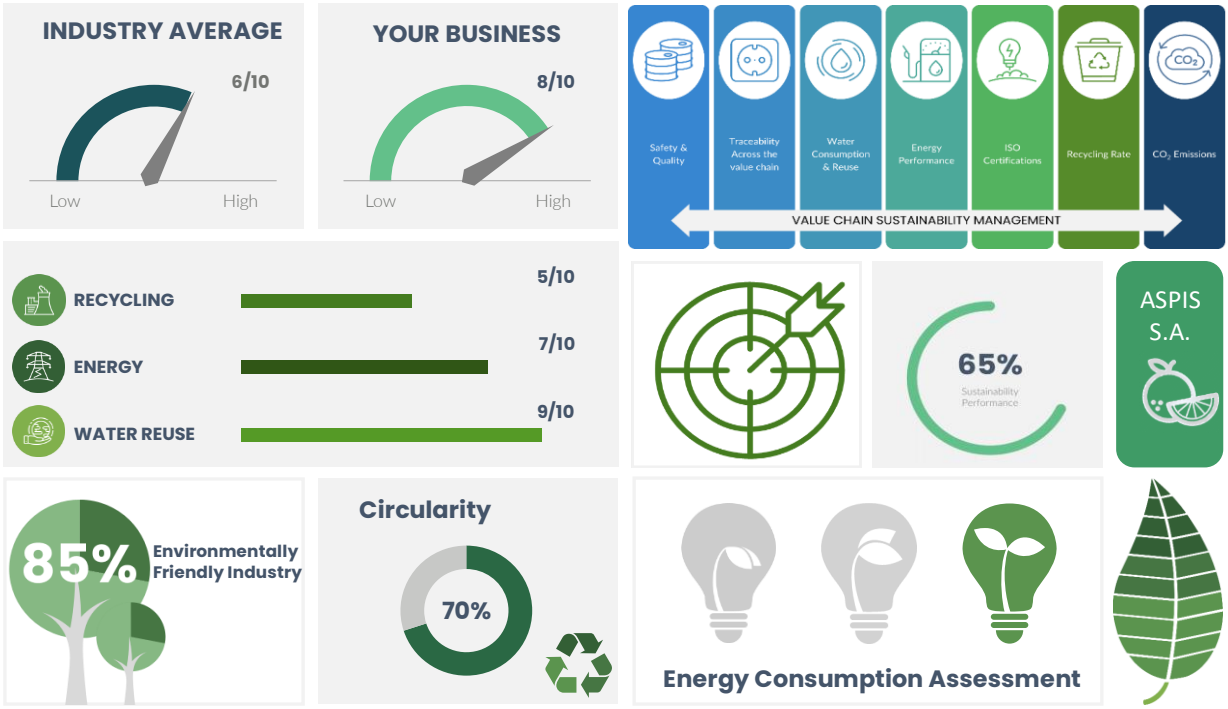

Figure 20: Mock-up of Environmental Assessment Dashboard *(indicative example of results)*

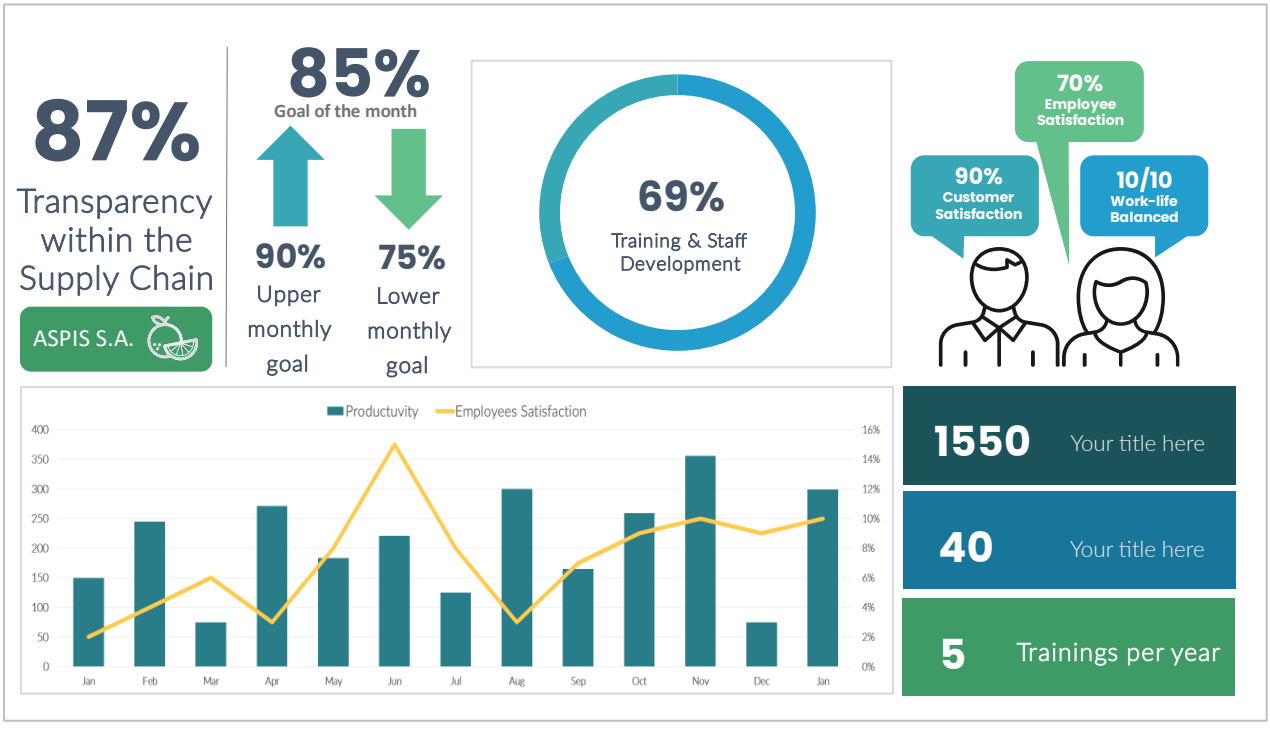

Figure 21: Mock-up of Society Assessment Dashboard *(indicative example of results)*

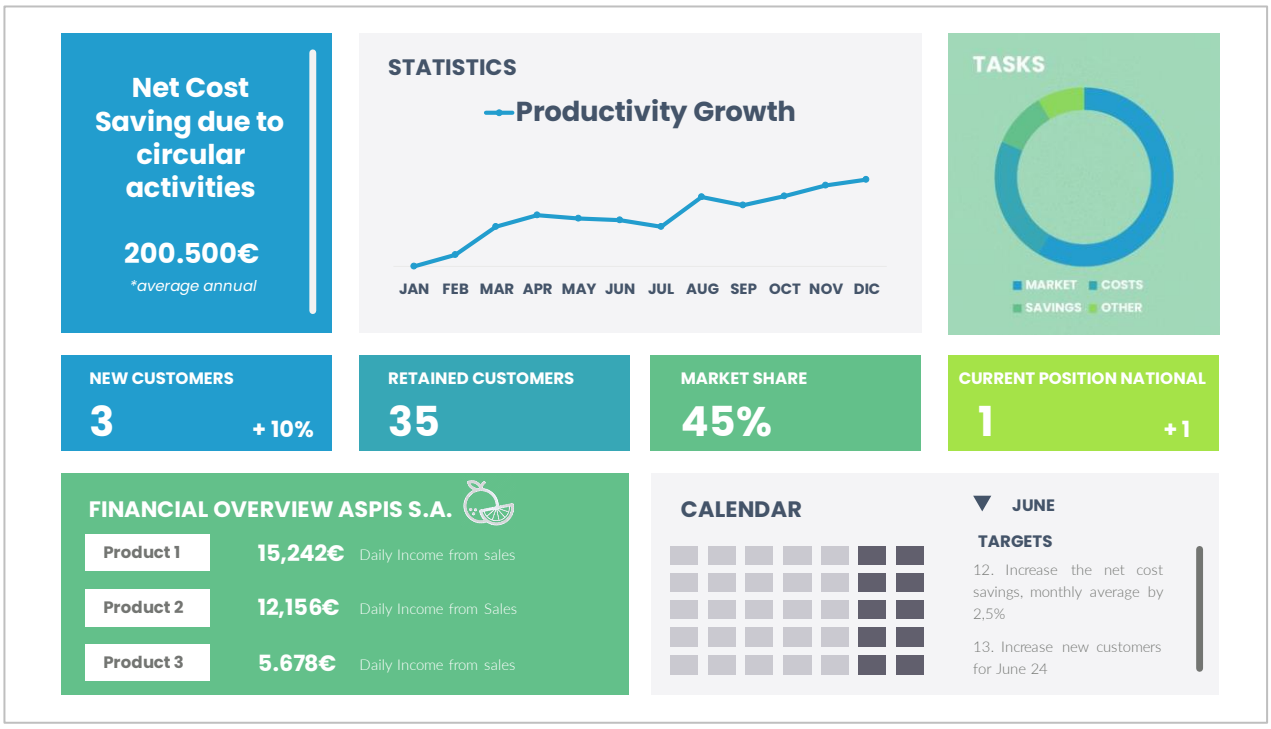

Figure 22: Mock-up of Economy & Growth Assessment Dashboard *(indicative example of results)*

The visualisations of Figure 19, Figure 20, Figure 21 and Figure 22 are indicative representations of the results derived from the SBSC assessment in relevance to the performance of the industry for the main pillars. Due to the nature of the tool/module and the main goal of the scorecard, to investigate the cause-and-effect pattern, comparison dashboards will represent the impact of one modification (i.e., by increasing the temperature in a selected process by 1°C).

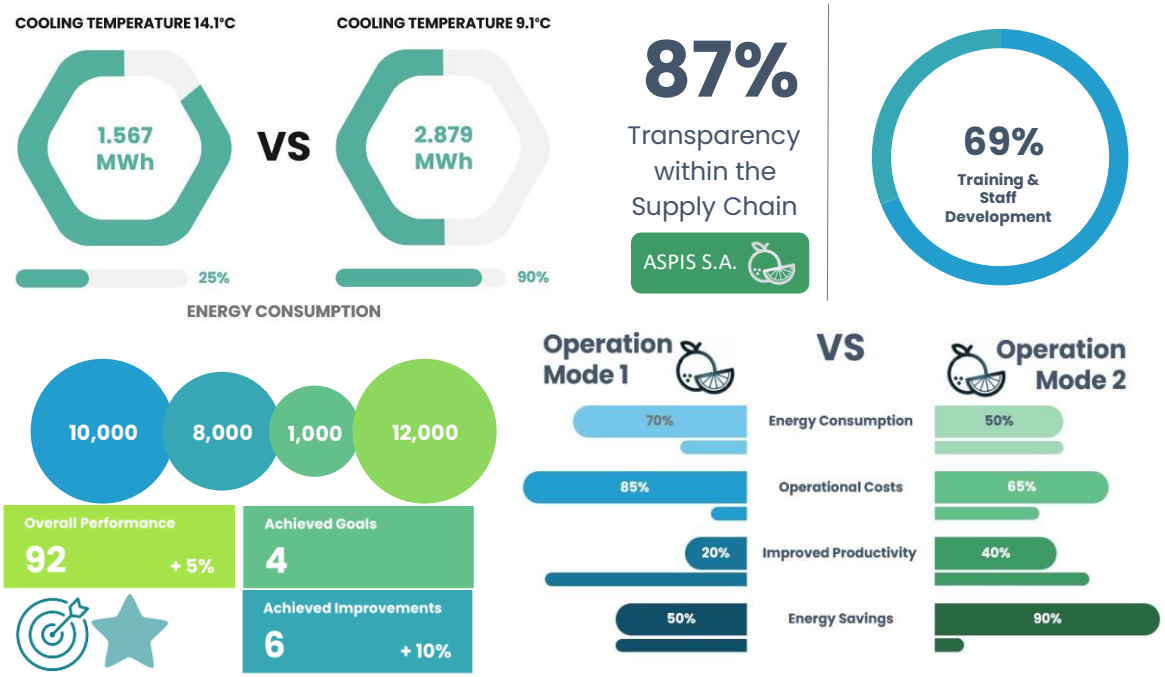

Figure 23: Mock-up of Comparison Dashboard *(indicative example of results)*

Conclusions

The Balanced Scorecard is a critical component of the project's vision, to empower the industries in achieving their green and digital transition and facilitate the sustainability and circularity assessment of their entire value chains. The customisable nature of the Plooto SBSC allows it to be tailored to the specific industry needs, ensuring that the assessment aligns with the unique sustainability goals and operational processes. This first deliverable outlines the implementation steps of creating the Plooto Balanced Scorecards, as well as the architecture of the tool, the technological background, and the way that it is adopted to each one of the Plooto use cases, in order to achieve its vision, to serve as a tailored-made tool, capable of assessing the investigated value chain in terms of environmental, societal, financial and growth, and governance aspects. But mainly, to showcase the impact of changes across the value chain, by modifying, either slightly or significantly, selected operational variables.

The Scorecard development encloses several essential points of attention. Critical aspect of the overall process is the close collaboration with the industry in order to initiate the scorecard as a customised service that will adapt to their needs and will facilitate the industries to effectively control the processes and KPIs according to their needs and perceptions. Therefore, the selection of the KPIs by the companies themselves, was crucial for initiating the tool customisation. Additionally, the data acquisition is critical as well, for creating the regression equations that will demonstrate reliable process models and provide dependable results of the cause-and-effect coefficients.

The Scorecard has been integrated into the PSM tool under the form of an interdependent module, that has been created and adjusted in the PSM tool. The regression equations that have been integrated into the PSM models for each of the use cases and which include the cause-and-effect coefficients, are calculated through the PSM. Therefore, the Scorecard shares the technical background of the Process Modelling and Simulation Service, as it has been described in D2.3.

To ensure the SBSC remains relevant and effective, continuous improvement based on user feedback and technological advancements are essential. Regular updates and enhancements will keep the tool aligned with evolving sustainability challenges. Additionally, enhancing the SBSC's compatibility with existing enterprise systems will streamline its integration into current workflows, making it easier for companies to adopt and use. Ensuring alignment with current and emerging sustainability policies and regulations will further enhance the tool's relevance, supporting industries in complying with legal requirements and driving significant advancements in industrial sustainability and circularity.

At this point, the procedure has been concluded for the KPIs selection, the processes selection (that generates the flowcharts), the KPIs interconnections across the production line, and the variables (dependent and independent) identification. Specifically, for the Greek pilot, the process model has been created and tested. Moreover, the draft visualisations have been created in the form of mock-ups for being further updated and finalised in the next deliverable of Plooto Scorecard, D3.6.

A strict and tight schedule has been designed and is currently followed, in order to deliver the tailor-made Scorecards for each of the Plooto use cases, test and evaluate the tool, and describe the outcomes of these activities in D3.6. Next steps include:

- Data collection from the pilots and evaluation of the models and equations for the Greek, the Spanish and the Italian use cases of Plooto.
- Development and distribution of questionnaires for gathering the KPIs that are qualitative or need feedback from the industries, as described in tables of Section 3.
- Run the models, calculate the cause-and-effect coefficients and validate the results.
- Make modifications, tests and updates in the models/equations, if necessary, in order to deliver validated results,
- Ensure the interoperability of the Plooto Scorecards with the Plooto platform and the services.

The implementation of the next steps, and their results, will be presented in detail in the next deliverable of Plooto Scorecard, the D3.6, on M30.

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Appendix A: Extended List of KPIs derived from the Plooto Sustainability and Governance Framework and KPIs' coding

KPI Name	*KPI Code in Plooto*	*KPI Category*	*Description*	*Unit*	*Eligible for category*	*Cause-and-effect*
Carbon Dioxide (CO2)	PLE01	Environment	Amount of CO2 released from the activities across the supply chain	kgeq	Carbon footprint	Sustainability
Methane (CH4)	PLE02	Environment	Amount of CH4 released from the activities across the supply chain	kgeq	Carbon footprint	Sustainability
Water stress/ consumption	PLE03	Environment	Amount of water consumed across the industrial processes	kg	Resources	Sustainability
Amount of water reused	PLE04	Environment	Amount of water reused across the industrial processes	kg	Resources	Circularity, Sustainability
Amount of water treated	PLE05	Environment	Amount of water treated before returning to the ecosystem	kg	Resources	Circularity, Sustainability
Energy consumption	PLE06	Environment	Amount of energy consumed across the supply chain	kWh	Resources	Sustainability
Use of RES/RES integration	PLE07	Environment	Amount of energy produced by RES	kWh	LCA/Resources	Sustainability, Resiliency
Fossil fuels depletion	PLE08	Environment	Amount fossil fuels reduction (or energy from RES) in consumed energy mix	kg or kWh	LCA/Resources	Sustainability, Resiliency
Transportation processes	PLE09	Environment	Consumptions related to the transportation/logistics (i.e., energy)	DOC	Resources	Sustainability
Green logistics	PLE10	Environment	Amount of emissions during logistics activities (warehousing and transportation)	kg	Resources	Sustainability, Resiliency
Supply chain waste	PLE11	Environment	Amount of distributed plastics	kg	Pollution and Waste	Circularity
Recycling rates	PLE12	Environment	Amount of recycled plastics	kg	Pollution and Waste	Circularity

Use of biodegradable materials	PLE13	Environment	Amount of biodegradable materials produced/used	kg	Pollution and Waste	Circularity
Packaging materials and waste	PLE14	Environment	Amount of waste from packaging material	kg	Pollution and Waste	Sustainability
Electronic Waste	PLE15	Environment	Amount of electronic waste	kg	Pollution and Waste	Sustainability
Scrap Waste	PLE16	Environment	Amount of scrap waste	kg	Pollution and Waste	Sustainability
Resource Utilization	PLE17	Environment	Percentage of use of non-renewable resources across the supply chain	%	Resources	Sustainability, Resiliency, Circularity
Consumption of virgin raw materials	PLE18	Environment	Amount of virgin raw material consumed	kg	Resources	Sustainability, Resiliency, Circularity
ISO22400 for traditional manufacturing	PLE19	Environment	ISO Certification that the company/industry meets the certification standards	-	Opportunities and Innovation	Sustainability, Resiliency, Transparency
ISO59020 for measuring and assessing circularity	PLE20	Environment	ISO Certification that the company/industry meets the certification standards	-	Opportunities and Innovation	Circularity
Health and Safety	PLS01	Society	Assessment health and safety conditions in the industrial company	Qualitative	Human Capital	Resiliency
Gender equity, inclusion, and diversity	PLS02	Society	Assessment of gender equity issues, inclusion and diversity in the industrial company (i.e., proportion of women/ men employees)	Qualitative	Human Capital	Transparency
Training and Staff development	PLS03	Society	Availability and implementation of training programs and staff development activities	Qualitative	Human Capital	Resiliency
Chemical safety	PLS04	Society	The industrial company meets the standards for safety from chemical materials	Qualitative	Product Assessment	Resiliency, Transparency
Product safety and quality	PLS05	Society	The industrial company meets the standards for product safety and quality	Qualitative	Product Assessment	Resiliency, Traceability
Privacy and data security	PLS06	Society	The industrial company runs in compliance with the regulations for privacy and data security	Qualitative	Product Assessment	Transparency

Transparency within the Supply Chain	PLS07	Society	The level of transparency regarding the quality and origin of the materials, the processing, etc.	Qualitative	Product Assessment	Transparency
Controversial Sourcing	PLS08	Society	Origin of materials or products (involvement in harmful or unethical practices)	Qualitative	Stakeholders	Transparency, Traceability
Supply Chain Liability	PLS09	Society	The legal responsibility of the industrial company for actions or shortcomings across its supply chain	Qualitative	Stakeholders	Transparency, Traceability
Customer satisfaction	PLS10	Society	Level of satisfaction of costumers from the product use	Qualitative	Stakeholders	Resiliency
Employee satisfaction	PLS11	Society	Level of satisfaction of employees in the company	Qualitative	Human Capital	Resiliency
Access to Health Care	PLS12	Society	Level of access of employees to medical services, treatment, and healthcare resources	Qualitative	Opportunities	Resiliency
Access to Finance	PLS13	Society	Level of access to external funding (i.e., research funding programs, loans, etc.)	Qualitative	Opportunities	Economic Advantage, Sustainability
Work-Life Balance	PLS14	Society	Level of balance between professional responsibilities and personal time	Qualitative	Opportunities	Resiliency
Board diversity	PLG01	Governance	Level of differentiation in backgrounds, skills and characteristics of an industrial company's board of directors	Qualitative	Corporate Governance	Transparency
Anti-competitive practices	PLG02	Governance	Number of practices that an industrial company follows to gain an advantage in the market (i.e., price fixing, bid rigging, market allocation, etc.)	Number of practices applies in a year	Corporate Behaviour	Transparency
Tax transparency	PLG03	Governance	Frequency of openly disclosing information of the industries about tax payments and strategies	Number of sharing information in a year	Corporate Behaviour	Transparency

Business ethics	PLG04	Governance	Number of practices for ensuring ethical principles i.e., environmental responsibility, product quality and safety	Number of practices applied in a year	Corporate Behaviour	Transparency
Expenses and fines on litigation incidents	PLG05	Governance	Expenses and fines on filings, lawsuits related to anti-competitive behavior, anti-trust and monopoly practices	€	Litigation Risks and Corruption	Transparency
Litigation risks payments	PLG06	Governance	Payments for addressing litigation incidents	€	Litigation Risks and Corruption	Transparency
Percentage of revenues in regions with TI corruption	PLG07	Governance	Percentage of revenues in regions with TI corruption below 0.6	%	Litigation Risks and Corruption	Transparency
Market share	PLEG01	Economy & Growth	The percentage of sales of a product related to all sales of that product for a specific time period i.e., per month, and for a specific geographic area (i.e., at national level)	Depends on the case/ available data, usually in € per specific month, per specific area	Finance	Economic Advantage
Asset utilization	PLEG02	Economy & Growth	How effectively uses a company its own assets to generate revenue	Qualitative	Finance	Economic Advantage, Resiliency
Net cost savings due to circular activities	PLEG03	Economy & Growth	Assessment of savings that coming from circular activities (i.e., re-use of materials or secondary raw materials, treatment of water to enter the process, etc.)	€	Finance	Economic Advantage, Circularity
Customer acquisition	PLEG04	Economy & Growth	Number of new incoming customers per year	No	Customer	Resiliency
Customer retention	PLEG05	Economy & Growth	Perception of customers remaining or leaving, per year or specific period	% (±)	Customer	Economic advantage, Resiliency
Customer profitability	PLEG06	Economy & Growth	Assessment of net profit generated by individual customers	€	Customer	Economic Advantage
Employee retention	PLEG07	Economy & Growth	Perception of employees remaining or leaving, per year or specific period	% (±)	Growth perspective	Economic advantage, Resiliency

Productivity growth	PLEG08	Economy & Growth	Percentage of increase in output/value generated per unit, for a specific time period	%	Growth perspective	Economic Advantage
Revenue growth	PLEG09	Economy & Growth	Percentage of increase in revenues/sales generating income, for a specific time period	%	Growth perspective	Economic Advantage
Compound Annual Growth Rate (CAGR)	PLEG10	Economy & Growth	Annual growth rate of an investment over a specific period of time, longer that 1 year [1]	%	Growth perspective	Economic Advantage
Prepreg shelf life	PLIT01	Pilot Specific KPI	Time period that prepreg can be stored and retain its specified properties	Time period		Pilot Specific
Prepreg disposal in HP	PLIT02	Pilot Specific KPI	Amount of discarding uncured or expired prepreg waste that generated in the industry	tons/year		Pilot Specific
Value of uncured prepreg scraps for HP	PLIT03	Pilot Specific KPI	Increase in value of uncured prepreg scraps	€/tons		Pilot Specific
New Jobs in partners facilities related to exploiting uncured prepreg scraps	PLIT04	Pilot Specific KPI	Number of new jobs related to uncured prepreg scraps	Number		Pilot Specific
Unused CFRP waste in the production of composite materials (%)	PLIT05	Pilot Specific KPI	Increase in the use of CFRP waste in the production of composite materials due to reuse	%		Pilot Specific
Reduce of the existing unused CFRP waste	PLIT06	Pilot Specific KPI	Reduction of the unused CFRP waste (related to PLIT05)	-		Pilot Specific
Production of animal feed	PLGE01	Pilot Specific KPI	Amount of produced animal feed	tons		Pilot Specific
Production of high-quality molasses	PLGR02	Pilot Specific KPI	Increase the amount of produced high-quality molasses	tons		Pilot Specific
Production of d-Limonene	PLGR03	Pilot Specific KPI	Amount of d-Limonene produced	tons		Pilot Specific
Volume of CPWW that goes to biological treatment	PLGR04	Pilot Specific KPI	CPWW to biological treatment	tons		Pilot Specific

COD of CPWW	PLGR05	Pilot Specific KPI	Chemical Oxygen Demand reduction in the Citrus Peels Wastewater	tons	Pilot Specific
Volume of CPWW that goes to biological treatment	PLGR06	Pilot Specific KPI	Volume of CPWW gores to biological treatment due to reuse/recycling	%	Pilot Specific
Revenues from animal feed	PLGR07	Pilot Specific KPI	Amount of revenues from animal feed transactions	M€	Pilot Specific
Improve energy savings	PLGR08	Pilot Specific KPI	Energy savings increase	%	Pilot Specific
Improve cost savings	PLGR09	Pilot Specific KPI	Cost savings increase	%	Pilot Specific
Reduction of WEEE landfilled (for the bonded materials' part)	PLES01	Pilot Specific KPI	Amount of WEEE that goes to landfill	tn/year	Pilot Specific
Usage of SRM (bonded NdFeb, Sr-Ferrite) in PM magnet pellets' production (%)	PLES02	Pilot Specific KPI	Increase of SRM in magnets' production	%	Pilot Specific
Number of types of validated materials	PLES03	Pilot Specific KPI	Number of types of validated materials	number	Pilot Specific
Recycling from leftovers and disregarded magnets (%)	PLES04	Pilot Specific KPI	Recycling from leftovers and disregarded magnets (%)	%	Pilot Specific
Improve the quantity of leftovers and disregarded magnets entered into the transformation process	PLES05	Pilot Specific KPI	Quantity improvement of leftovers and disregarded magnets entered into the transformation process	%	Pilot Specific
Increase the usage of SRM (bonded NdFeb and Sr-ferrite) in PM magnets pellets' production	PLES06	Pilot Specific KPI	Increase the usage of SRM (bonded NdFeb and Sr-ferrite) in PM magnets pellets' production	%	Pilot Specific
Increase the usage of Sr-ferrite crushed pellets in magnets production	PLES07	Pilot Specific KPI	Increase the usage of Sr-ferrite crushed pellets in magnets production	%	Pilot Specific

Minimisation of raw materials insertion	PLES08	Pilot Specific KPI	Amount of raw materials inserted into the production line	%	Pilot Specific