MAGNO

Transforming EU food systems with innovative strategies for sustainable packaging

WP1 – Set-up of MAGNO for sustainable and smart solutions on packaging

D1.3 – Key Performance Indicators

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Executive Summary

The main goal of MAGNO is to develop outcomes and validate strategies that prevent and reduce plastic packaging pollution in the food and packaging sectors. To this end, the project aims to improve packaging effectiveness through sustainable practices. These focus on actions that encourage efficient use and end-of-life management, primarily considering reuse and recycling. It also promotes innovative business practices within EU food systems. Furthermore, MAGNO seeks to boost social innovation, consumer engagement and the acceptance of new packaging designs and production models across food value chains.

In this context, this document details the work carried out under Task 1.4 "KPI validation and detailed definition". It serves to define and describe the Key Performance Indicators (KPIs) applicable to the MAGNO project. These KPIs evaluate the impacts caused by circular approaches and new business strategies on the packaging value chain in the food system.

Therefore, the KPIs framework elaborated in this deliverable provides a systematic, measurable method for evaluating the project's progress. The KPIs, some of them established at the project's outset, aim to provide a clear measure of progress and the achievement of the project's objectives. To complete the indicator map, a detailed table characterizing these KPIs was prepared and discussed with all the project partners during the execution of the deliverable. This table gave rise to the KPI tables presented in the document and mostly present in the results and discussions in session 6. The aim was to refine the KPIs to ensure their comprehensive understanding and alignment throughout the duration of the project.

The definitions of the KPIs are linked to the environmental, economic, and social areas that have been outlined based on the project's specific strategies and objectives. These include in their scope sustainability, manufacturing, packaging use and health factors. The aim is to cover all phases of the defined circular approach. This coverage includes the factors that interact with the business model, the methodology used, and the target scenario to which the KPIs are linked. HOL was responsible for defining the target KPIs. All the MAGNO partners validated the circular approach and the target KPIs. This report and, consequently, the creation of the complete KPI framework will allow the successful evaluation of the different scenarios outlined during the project proposal.

Based on the development and monitoring of this KPIs framework, the MAGNO project successfully demonstrates a quantifiable measure of its achievements, highlighting the potential for future enhancements. The KPIs are poised for implementation across various value chains within the plastics industry and potentially into other sectors. Looking ahead, MAGNO's innovations are designed for expansion, promising to deliver significant environmental, health, and economic benefits. This deliverable lays a robust foundation, enabling ongoing improvements. It charts a strategic path forward, establishing quantifiable benchmarks for future sustainability innovations.

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Abbreviations

BSC	Balanced Score Card
CAPEX	Capital Expenditure
CE	Circular Economy
EoL	End-of-life
EPE	Environmental Performance Evaluation
GA	Grant Agreement
ISO	International Organisation for Standardisation
KPI	Key Performance Indicators
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LCSA	Life Cycle Sustainability Assessment
LE	Linear Economy
OPEX	Operational Expenditure
Pr-CA	Preliminary Circular Approach
SCOR	Supply-Chain Operations Reference
s-LCA	Social Life Cycle Assessment
SOs	Specific Objectives
UNEP	The United Nations Environment Programme

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1. Introduction

MAGNO aims to improve the efficiency and sustainability of the packaging sector to boost food systems, by studying and applying effective and sound production methods (including fit-for-purpose solutions, health, and environmental impacts). Furthermore, the project intends to promote the adoption of solutions to effectively reduce the impact of plastic food packaging pollution on ecosystems. This objective involves creating a web platform for consumers and packaging manufacturers. It also entails developing Digital Twin Ecosystem software for comprehensive life cycle solutions. The aforementioned approach will evaluate food systems with the considerations developed in MAGNO. Additionally, it will provide a breakthrough in the transition to a Circular Economy (CE) in the European Union.

In this context, the project explores manufacturing, raw material, production, and design routes through WP1-4. It aims to identify best practices for implementing available food packaging systems. The WP1—"Set-up of MAGNO for sustainable and smart solutions on packaging"— aims to perform an efficient and comprehensive project structure for managing organisational and scientific/technical topics. It Includes the preparation of periodic reports and define the dependencies between all working groups and the boundary conditions of each activity. In addition, it will also take legal, financial, and economic aspects of quality control into account. The project will be developed using as a foundation all the subjects addressed in this WP.

Task 1.4, a primary focus of WP1, aims to quantify MAGNO's impact using a contemplative list of KPIs. It assesses its relation to new plastic packaging strategies in the food system. The definition of the KPIs will include the environmental, economic, and social indicators that must be assessed throughout the value chain during the execution of the project. Furthermore, in addition to sustainability factors, it will also include manufacturing, health, and packaging use factors.

The KPI database was created according to the packaging value chain, available sources, materials databases (e.g. Materials Genome Initiative, AFLOW) and related projects. This value chain considers the stages of design, raw material, polymer production, product production, retailer, use and demand, and waste management (reuse and recycling). As the project develops, strategies for the circular approach will be modelled using KPIs as a measure of impact. This will be mainly based on results from T3.5, T4.5, and T5.5, the assessment will be supported by Tasks 2.5 and 2.6 demonstrations.

2. Purpose of the Document

KPIs are a tool for monitoring the progress of a project. As such, this document sets relevant KPIs to assess circular approaches and new business strategies proposed by MAGNO for food packaging. The KPIs definition will allow decisions to be made and strategies to be created based on the proposed objectives.

Different impact and indicators will support the results that must be achieved during the progress of the study of the food packaging value chain. The selected KPIs will cover specific stages in the value chain, including raw material use, waste generation, recycling, production, and costs. They encompass packaging health, safety, investment, and operating

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expenses. Based on the different stages of food packaging that will be addressed in the project, the KPIs will demonstrate the real impact that MAGNO will have on the sector.

Thus, this deliverable aims to define the initial KPIs for the processes that the MAGNO project covers. Based on these indicators, it will be possible to measure and evaluate the performance and results achieved throughout the life of the project. This will contribute to the formulation of solid circular strategies to combat plastic pollution and transform the current value chains into more circular and sustainable ones.

3. Relevant Background

3.1. Current Context

Global plastics production increased by 2.5% between 2021 and 2022, from 394 to 400.3 million tons. Over the last 5 years, Europe has maintained a production base of approximately 60 million tons per year, of which around 80% were fossil-based plastics [1] [2]. The estimated consumption of plastic per year is 45 kg per person [3]. Plastic packaging dominates in usage and waste, with 40% of global production directed towards food packaging, significantly impacting consumers daily [4].

The food industry links its use to its entire value chain, emphasising production and logistics, making it a vital element for food safety. However, the continuous and growing use of plastics, without efficient management of their value chain and End-of-Life (EoL), leads to several negative environmental, economic, and social impacts. Several harmful effects are associated with poorly managed plastic contact with food and the environment [5].

Microplastics have been found in human bodies, with an estimated intake of 5 grams of plastic per week [4]. In addition, around 65% of plastic waste is not yet valorised in the CE. It is also predicted that 86% of the plastics produced will be landfilled, incinerated, or leaked by 2040 [6] [7]. Additionally, the culture of single-use packaging exacerbates this, leading to negative environmental, economic, and social impacts. Besides that, it is estimated that plastic production accounts for 4.5% of global greenhouse gas emissions. The data underscores the issue of linear production and rampant consumption, bolstered by single-use culture. There's a deficiency in promoting recycling and reuse initiatives [8].

In this context, several EU policies aim to change the scenario in the medium and long term, up to 2035 and 2050. They are also in line with the Paris Agreement and the Glasgow Climate Pact, the goals of the European Green Deal and the CE Action Plan [1] [2]. These changes in production modes, as well as the transition from linear to circular chains, will aid in the sector's transformation at various stages of the value chain. These changes in production modes, as well as the transition from linear to circular chains, will aid in the sector's transformation at various stages of the value chain. In this sense, the European plastics manufacturing industries are in transition to adapt their processes to reduce pollutants throughout the value chain.

The CE is a viable alternative to the current linear system on which the production, use and disposal of plastic are based. Its goal is to increase the amount of reusable and recyclable plastic returned to the production system, either as raw material or as a retail product. An approach encompassing "upstream" actions like material redesign and exploring new raw materials, along with "downstream" actions like recycling, is essential. It addresses

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both pre- and post-consumer stages effectively. These actions are aimed at a transition to cleaner processes with fewer cross-cut impacts, cradle-to-cradle, which contribute to aligning processes with the actions addressed by the EU [1] [5].

3.2. Linear vs. Circular Economy

The Linear Economy (LE), driven by the relentless pursuit of maximum profit, emerged as the dominant economic model of the 20th century. The model is founded on the principles of large-scale product production and the constant creation of new consumer demands. Thus, the use of raw materials and energy at minimum cost to satisfy production needs, while at the same time increasing product prices and encouraging unbridled consumption [9] [10].

Characterised as "take-make-waste", LE puts economic performance at the forefront. Thus, after use, products become waste and are disposed of in landfills or undergo other processes, i.e., incineration. Given this, the model neglects issues such as recycling and reuse, since they are associated with making the process more expensive, and policies against unbridled consumerism [11].

The rise in raw material prices, coupled with unpredictable fluctuations and environmental regulations, underscores the urgency for change. Transitioning to a CE addresses these challenges by decoupling income from material consumption.

The main objective of the CE is to transform the value chains more sustainably, in terms of process and product [11]. These practices are described in frameworks such as the 10R, which aims to demonstrate the actions and new stages that can be implemented to replace the EoL practiced. The objective of 10R is to create a more sustainable process while conserving natural resources through regeneration and preservation. It involves eliminating toxic chemicals and waste while incorporating renewable energies [12] [13].

Figure 1 shows the main stages associated with the 10R. Each "R" represents a stage linked to the circularization of the process. Each process represents a stage linked to the circularization of the process. They all represent strategies that guide how circular design and manufacturing can keep resources in use and waste out of the environment.

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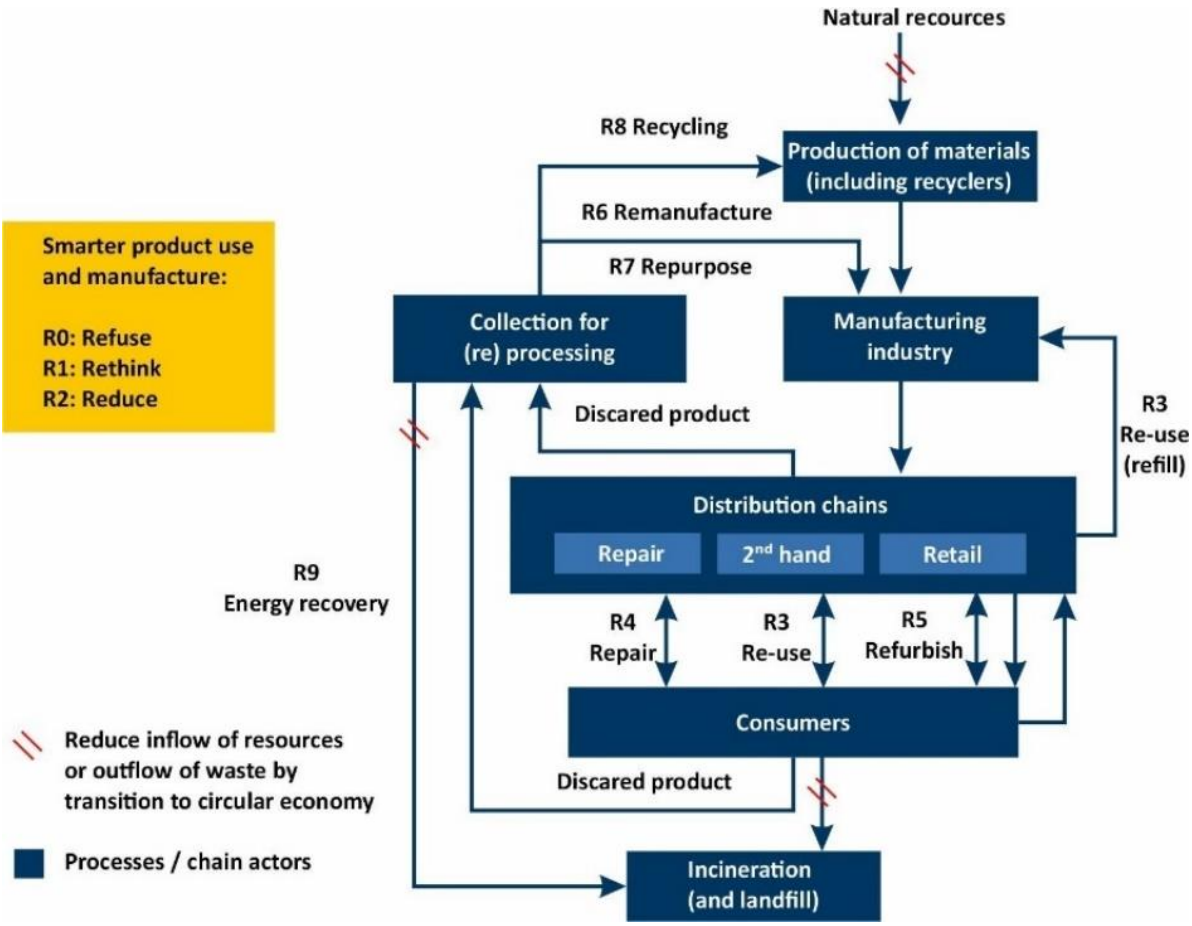

Figure 1. Stages of 10R. Adapted from [13]

In addition to aligning with environmental policies and needs, the circular model helps to structure new economic models that support green ecological marketing strategies. However, the dynamic response to market demands necessitates transitioning between production models, impacting the entire value chain structured for production, consumption, and disposal. In this view, it is necessary to establish means, products and business systems that satisfy and create the conditions for a satisfactory transition for all the agents involved. Encouraging investment in inventive solutions fosters economic recovery by minimising waste and promoting reuse, recycling, and productive economic models, enhancing consumer satisfaction [14].

The necessity to develop methods and structures that support the transition has contributed to the development of new research that encompasses manufacturing with a holistic approach. In this sense, encompassing the concepts presented in *Figure 1*, the Ellen Mac Arthur Foundation developed the "butterfly diagram", as shown in *Figure 2*. The diagram illustrates how current value chain processes following the LE structure should incorporate CE concepts. It discusses general processes for effectively integrating CE ideas.

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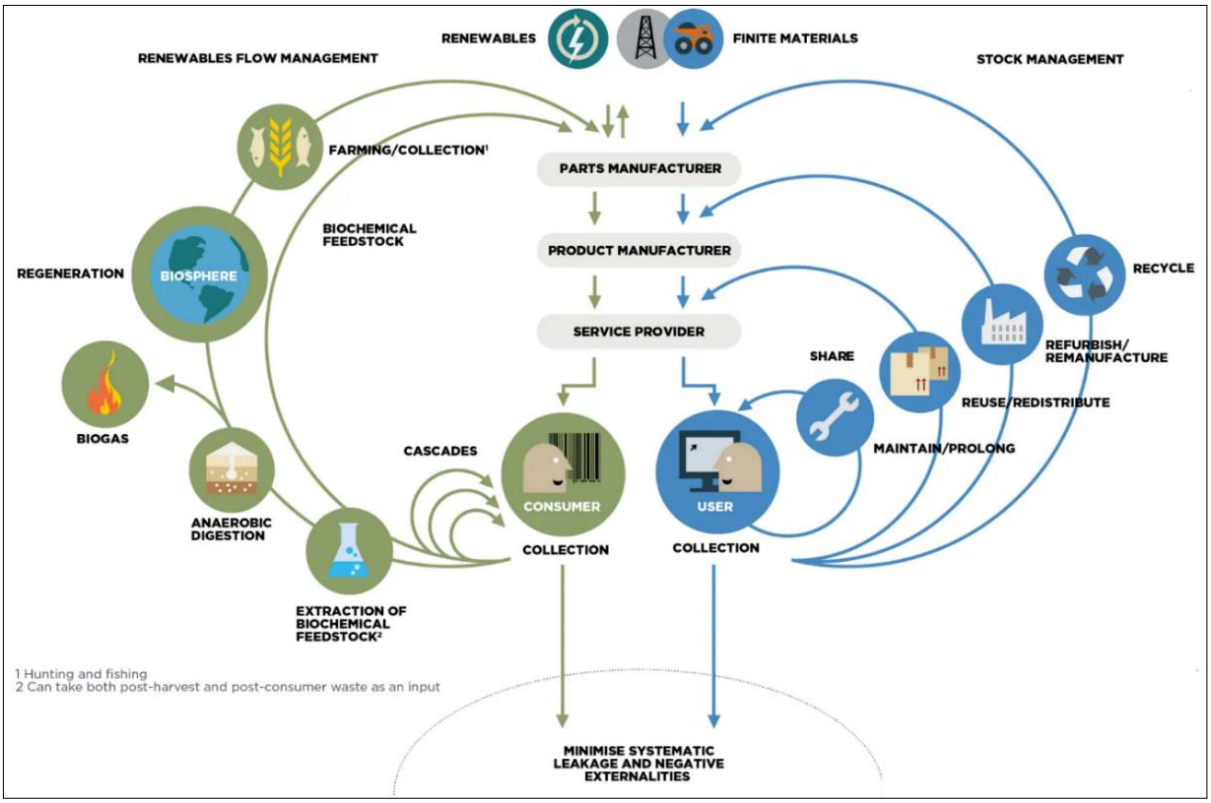

Figure 2. Butterfly diagram [15]

The column on the central axis of *Figure 2* represents LE, with the extraction and obtaining of raw material, manufacturing, consumption, and waste. In contrast, all the other stages represent the stages of 10R (*Figure 1*) that could potentially encompass CE, such as maintenance, reuse, remanufacturing, and recycling. Additionally, *Figure 2* shows a distinction within the circular approach in terms of the processes, the technical cycle (blue arrow) and biological cycle (green arrows).

The technical cycle involves returning products, components, or materials to the main system when they cannot degrade or contain toxic components harmful to humans and/or environment. After the collection stage, this return can be through maintenance, reuse, remanufacturing, or recycling. By contrast, the biological cycle refers to materials that can biodegrade, returning to the biosphere naturally. The collection enables CE stages to be linked with cascades, reusing materials in new designs with added functionalities. Regenerative systems feed back into the biosphere, reconstructing natural capital [15].

The use of raw material, design and manufacturing directly influence the process that will be required to frame the CE. Different paths and routes can be taken, using the different techniques and possibilities that exist at each stage of the value chain. Therefore, an in-depth and contemplative study that addresses both the isolated and in-process stages is needed. This would aid in the creation of different paths and possibilities for transforming the packaging food value chain into a circular one.

In this context, the MAGNO project aims to develop, a series of circular solutions that contribute to production and the system that involves packaging plastic. Based on the

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innovations and results proposed in WP3, and WP4, including the particularities of each stage with the EoL strategies proposed in WP5.

Performance measurement of developed work and systems, along with circular approaches, will assess the best routes within each value chain stage. Metrics and indicators (KPI) developed in the project will evaluate environmental, social, and health impacts.

3.3. Key Performance Indicators (KPI)

KPIs are a set of indicators used to measure and evaluate the performance of activities, processes or operations based on pre-established metrics over a given period. Based on a strategic interpretation aimed at identifying potential vulnerabilities, evaluation, and benchmarking, they are measured by comparing data with key objectives. Given that, and, depending on the response found, the progress made will be demonstrated [16].

The creation and modulation of the indicators will be used as metrics to measure the success of the evaluated process. Naturally, there must be full knowledge of the initial process and the final objective that is to be achieved. Therefore, once the KPIs have been aligned with the process, the actions and routes taken can be designed accordingly [17].

To guide the formulation of KPIs, different methods and standards can be applied, which must be in line with the specific needs required in the system. For value chain KPIs, methodologies like Specific; Measurable; Attainable; Realistic; and Timely (SMART), Balanced Scorecard (BSC), Supply-Chain Operations Reference Model (SCOR), and the International Organisation for Standardisation (ISO) standards are proven useful tools with broad applicability. They address diverse needs effectively.

According to the SMART methodology, the construction of KPIs should follow five main lines: Specific; Measurable; Attainable; Realistic; and Timely, which will contribute to their implementation. Therefore, each KPI developed must be directly related to a specific process, which must be attainable and realistic within the period proposed for its realization. In addition, its association with a responsible person contributes to good execution and targeting of results [17] [18]. Ergo, the application of this methodology facilitates the visualization and interpretation of the process and results.

The BSC is a strategic performance measurement and management tool with a mix of operationalized strategies. Besides that, it has a set of measures that considers financial performance, customer satisfaction, internal business processes and innovation and learning. The results for each area will provide an overview of strategic progress through reports in the financial and operational areas. This will make it possible to observe and monitor the progress made [19].

The SCOR is a diagnostic tool for supply chain management. Its objective is to approach the value chain encompassing efficiency with measurable and actionable indicators. That will be based on the management of natural resources and the environmental performance of supply chain processes. Such comes from the 5 management processes, namely Plan, Source, Make, Deliver, and Return. Thus, it results in a contemplative understanding of the development of processes and the identification of the characteristics that lead to customer satisfaction [20].

As strategic tools, international standards have been drafted to facilitate quality and interaction between processes and companies. In this sense, two ISOs stand out for

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presenting methodologies that contribute to the implementation and visualization of KPIs: ISO 22400 and 14031. ISO 22400 defines the evaluation of performance in manufacturing operations. Its standard describes concepts and methods, as well as presenting a set of KPIs previously prepared for the implementation and measurement of manufacturing. ISO 14031 links KPIs with Environmental Performance Evaluation (EPE), enabling companies to measure, evaluate, and communicate environmental performance within processes [21] [22] [23].

Life Cycle Assessment (LCA) serves as a methodology to measure Environmental Performance Evaluation (EPE). It identifies indicators for environmental, operational, and management aspects, aiding continuous improvements. Its use becomes plausible and useful when related to the ways of measuring KPIs. Furthermore, Life Cycle Assessment (LCA) measures Environmental Performance Evaluation (EPE) and identifies indicators for environmental, operational, and management aspects, facilitating continuous improvements [24].

Based on the SMART methodology and applying the 5W2H framework, the KPIs were developed, covering all the points on which the MAGNO project will be working. Session 5 will explain the methodology applied to constructing and modelling the KPIs in detail.

3.3.1. Life Cycle Sustainability Assessment (LCSA)

Considered to be a sophisticated tool for measuring the sustainability of a process, the LCSA covers different indicators in terms of environmental, social, and economic dimensions. By addressing the entire life cycle (in relation to the process being addressed), all stages of the value chain are considered, from the extraction of raw materials, to EoL. The association of LCSA with KPIs directly relates to (I) the measurement tool based on circular approaches and MAGNO-generated knowledge, and (II) categorising KPIs related to holistic dimensions they're associated with [25] [26].

The framework for the development of the LCSA encompasses the integration of the three pillars of sustainability: Environmental Life Cycle Assessment (LCA), Life Cycle Costing (LCC) and Social Life Cycle Assessment (s-LCA). Despite being approached with indicators that cover different aspects, their execution and interpretation will be linked to identify potential trade-offs and also to relate the obtained results.

Based on ISO 14040 and 14044: 2006, LCA aims to assess inputs, outputs, and potential environmental impacts of a product system throughout its life cycle. The other two dimensions have no specific ISO, so they use the steps presented in ISO 14040 and 14044:2006 as a baseline, combining them with other guidelines. The LCC focuses, among other, on Capital Expenditure (CAPEX) and Operational Expenditure (OPEX), covering all internal and external costs related to a process or product over its life cycle. Given this, it considers manufacturing costs (from the business perspective) and life cycle costs (from the customer perspective). The s-LCA, aligned with ISO 14040, UNEP Guidelines, and Orienting EU Horizon 2020 project recommendations, emphasizes the "people" pillar within sustainability. Its aim is to thoroughly examine how goods and services affect society throughout their existence [27] [28] [29] [30].

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Figure 3 represents the LCSA with the components and the framework with the main steps required for implementation.

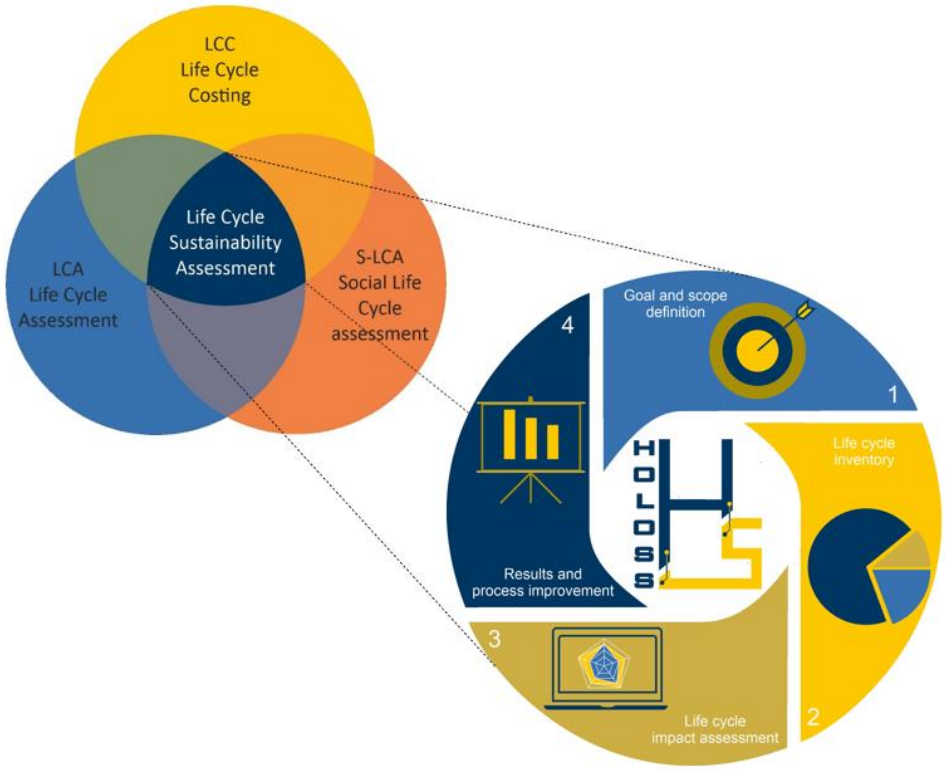

Figure 3. LCSA composition and framework.

The framework in *Figure 3* outlines the four main phases of LCSA development: goal and scope definition (I), life cycle inventory (II), life cycle impact assessment (III), and results and process improvement (IV). In the goal and scope definition phase, the objectives and boundaries of the LCA are outlined. Following this, the life cycle inventory phase involves collecting data on the inputs and outputs of each stage of the product's life cycle. Including raw materials, energy consumption, emissions, and waste generation. Subsequently, in the life cycle impact assessment phase, the collected data is analysed and processed to assess the potential environmental, social, and economic impacts. Finally, in the results and process improvement phase, the assessment results are interpreted, and recommendations are made. This phase often involves identifying opportunities for optimisation and implementing strategies for more sustainable practices [31].

The connection between LCSA and KPIs lies in its role as a tool for measuring impacts. It also serves as the basis for structuring KPIs into associated dimensions. In this sense, MAGNO aims to link KPIs with the target scenario it extends to, utilising LCSA as a tool for assessing impacts. This approach will be better described in section 5, applied methodology.

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4. Target Scenario

One of the main objectives of the MAGNO project is to develop new routes based on an extensive study of the different stages of the plastic packaging value chain. The circular approach will meet the environmental, economic, and social policies and objectives proposed by the EU. The circular approach aims to contribute to reducing the impacts associated with the rampant production and consumption of plastic. As such, it intends to develop implementable alternative routes and contribute to an ecosystem promoting reuse and recycling to reduce plastic waste.

As the project progresses, the construction of the KPIs closely aligns with the anticipated actions and results. The proposed KPIs aim to monitor responses obtained by technologies and paths at each stage of the food packaging value chain. This facilitates the creation of new circular approaches and business strategies. In this sense, the creation of a preliminary circular approach that will serve as the basis for the target scenario is essential.

Figure 4 (A) shows the Preliminary Circular Approach (Pr-CA) that will be used to associate the KPIs developed for MAGNO. As demonstrated, each stage is involved and encompassed in at least one task, with an associated partner. All the stages will be properly studied and developed so that different routes and ECs can be created and developed. In this sense, *Figure 4* (B) connects the different stages addressed by the circular approach with the specific tasks that the MAGNO project will develop.

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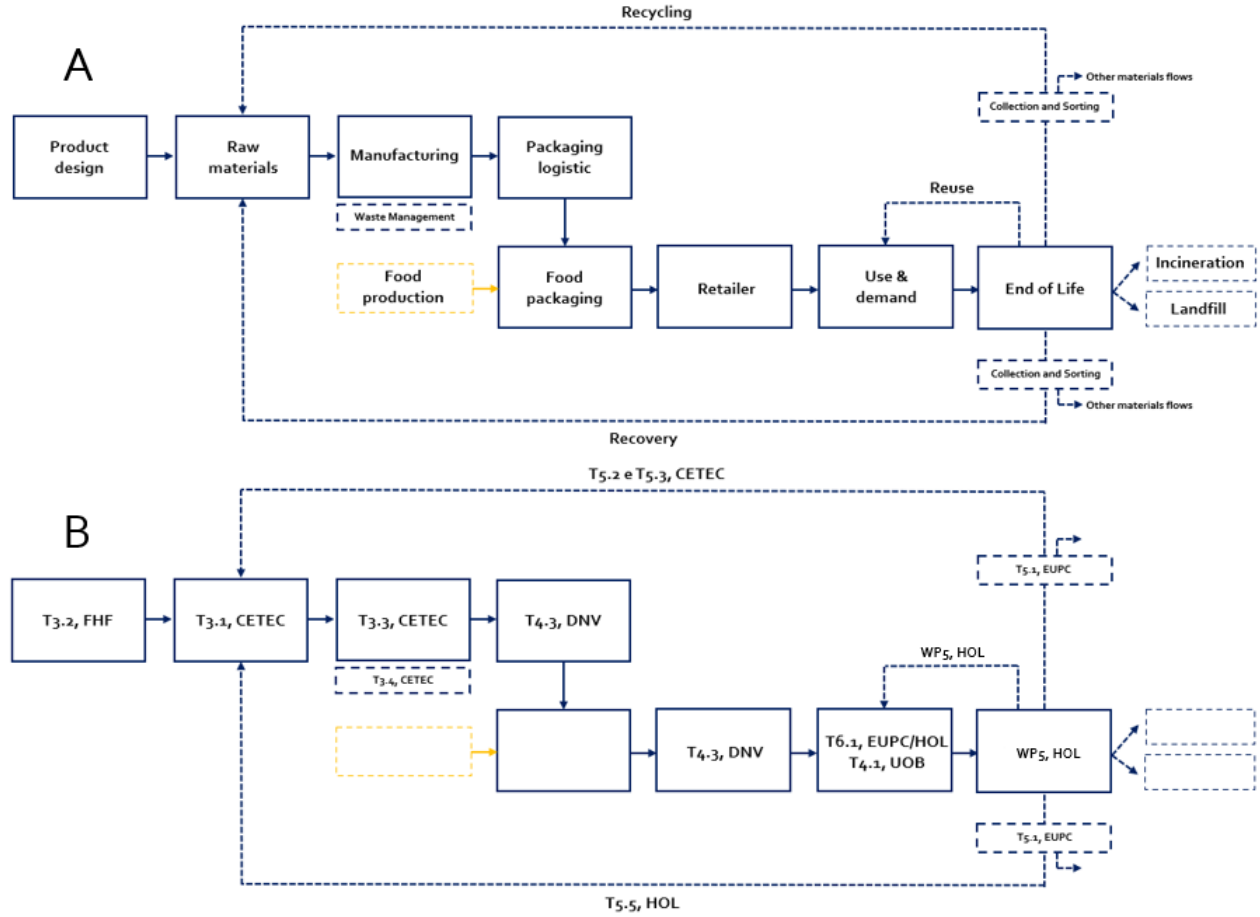

Figure 4: (A) MAGNO` Preliminary Circular Approach; (B) Relation between MAGNO Tasks and Partners with the stages in the Preliminary Circular Approach.

The Pr-CA is intended to visually demonstrate the main points that the MAGNO project will cover. It will be used as a basis for the development of the project's results and the construction of the new approaches to which the project aims to achieve. As mentioned, all stages are associated with a specific task. However, the "Food packaging" stage, in which the packaging meets the food, i.e. is filled with the food, is not directly associated. This stage is considered a "transition stage", in which the object fulfils its purpose. It is recommended that both food production and food packaging be produced under the label of "Commercial food operations", since these two activities usually take place in the same facility. Food operators are actors included in Table 4 of the GA and will be considered in MAGNO through the multi-stakeholder approach.

By analysing the entire scope of the MAGNO project and the development present in the WPs, related to Pr-CA, it is possible to divide the project into two periods (stages). Stage (I) refers to the development of the different lines of research for each stage, mostly carried out between months 1 and 30. Stage (II) involves maturing and interpreting results, crucial for constructing circular approaches, primarily between months 25 and 42 of the project. This division will assist in understanding the project's stages and the timeline for measuring the KPIs. It also helps to align expectations of the project's development in relation to the results.

Table 1 lists the stages described in the Pr-CA with the diversification of the lines of research that will be carried out within the MAGNO project in stage (I).

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Table 1. Development carried out in stage (I) of the MAGNO project.

Stage from Pr-CA	Main responsible (Leader)	Partners	Task	Timeline
Product design	FHF	CETEC, EUPC, PCEU	3.2	M07-M24
Raw material	CETEC	FHF, HOL, DNV, EUPC, PCEU, UOB, INSTM	3.1	M01-M18
Manufacturing	CETEC	FHF, DNV, IDE	3.3	M13-M30
Packaging logistic	DNV	FHF, EUPC, PCEU, INSTM	4.3	M18-M36
Retailer	DNV	FHF, EUPC, PCEU, INSTM	4.3	M18-M36
Use & demand	EUPC/ HOL UOB	All	6.1 4.1	M01-M36 M01-M24
End of Life	HOL	All	WP5	M01-M42
Waste management	CETEC	HOL, FHF, EUPC, PCEU, UOB, INSTM, UOS	3.4	M07-M36
Reuse	HOL	All	WP5	M1-M42
Collection and sorting	EUPC	All	5.1	M01-M24
Recycling	CETEC	HOLOSS, FHF, EUPC, DNV FHF, EUPC, DNV	5.2 5.3	M13-M30 M13-M30

The Pr-CA, shown in *Figure 4*, was built based on the stages described in the G.A. Building upon stage (I) and advancing through stage (II) enables the creation of detailed circular approaches. These will be compared with the preliminary plan, showcasing project progress. In this sense, the results that will be measured in the KPIs are strictly related to the results generated in these tasks.

The results generated will be evaluated and compiled for the tasks associated with stage II. Once completed, it will be possible to evaluate the results of the MAGNO project. *Table 2* shows the tasks associated with stage (II) and their expected results.

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Table 2. Development carried out in stage (II) of the MAGNO project.

Partners (Leader)	Task	Timeline	Description of the expected results
CETEC	3.5	M25-M40	Knowledge of raw material alternatives, design options, production and waste reduction measures will be defined within this task
UOB	4.5	M25-M40	The improvements for packer, warehouse, and retailer systems, as well as the definition of novel standards and legislation
HOL	5.5	M25-M40	A set of circular solutions will be developed after the definitions of recycling (T5.1-T5.3), sustainability (T5.4) and different value chain stages are defined in WP3 and WP4
KVC	6.2.2	M25-M42	After the definition of stages in WP3, WP4, and WP5, a collection of business strategies will be compiled (ST6.2.1 and T7.3); Furthermore, it will be focused on finding and collaborating with muti-actors to set the basis for future market and business deployments
DNV	7.3	M13-M42	
IDE	2.6	M31-M42	All the results from WP3, WP4, WP5 and WP6 will be tested, with the scenarios generated with the DT, to select the best strategies for the MAGNO project

Connecting KPIs with described stages, tasks, and associated leaders ensures alignment for effective indicator monitoring. This alignment ensures that objectives are accurately tracked. This way, it is easier to follow up on the results and identify and correct gaps, if necessary, in their measurement.

5. Methodology Applied

The methodology begins with a review of the proposal and similar initiatives to identify commonly used KPIs. These KPIs align with the project objectives. Insights from this review aid in drafting an initial list of KPIs, each aligned with specific project goals to accurately reflect the intended outcomes. This alignment is crucial to ensuring the KPIs effectively measure project success.

After this, the draft KPIs are shared with project partners for feedback, which enables their refinement to ensure clarity and relevance across all project dimensions. Establishing baseline values and defining measurement criteria for each KPI is the next critical step, particularly important where historical data is sparse. Partner opinions are instrumental here, helping to set realistic targets.

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The development of the KPIs was based on the 5W2H framework, with the aim of helping to formulate strategies for the development of action plans [32]. Therefore, by using the "5W2H questions" associated with the framework, the indicators that will guide the development of the project were developed. Then, a matrix maps each KPI to the corresponding project objectives, ensuring that all objectives are measurable and tracked.

Table 3 shows the relationship between the tool and the development of the KPIs.

Table 3. Framework used to develop the KPIs for MAGNO project.

5W2H "questions"	Definition considering the development of MAGNO`s KPI
What	Acronym and description of the KPI
Where	Area associated with the KPI
Who	Directly responsible for developing the KPI-related work
When	Reassessment and goal-setting time
Why	Motivation for establishing the KPI
How	Development of the data and actions required for KPI execution
How many	Target associated with the KPIs

Each KPI is categorised under dimensions like environmental, economic, and social for a balanced sustainability approach, as depicted in *Figure 5*. In addition, a fourth category "others" was created to cover KPIs of the project that do not interact directly with the three dimensions mentioned. All these categorisations help to seamlessly integrate the KPIs into the work packages of the project, assigning specific tasks to different partners or teams. Such assignments embed KPI tracking within project execution, fostering accountability and focus.

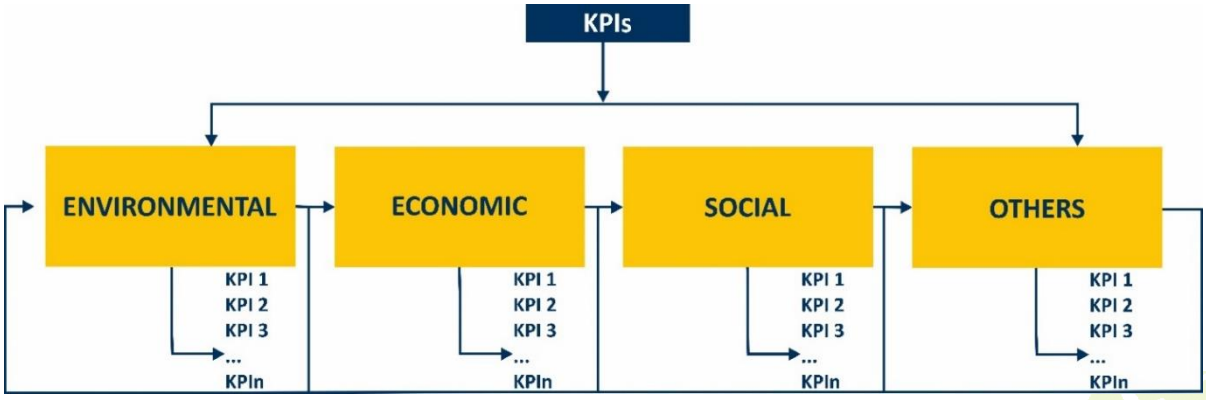

Figure 5: MAGNO`s KPI categories.

A routine is established for updating the progress against these KPIs annually during project meetings (session 6.5). This not only provides ongoing insights into project performance, but also accommodates the need to adjust KPIs in response to feedback, potential deviations, or external factors.

Regular communication with all stakeholders about the status of KPIs will be maintained through stakeholder and multi-actor involvement in the food system events

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(WP7). This will ensure transparency and foster a collaborative environment. At the project's conclusion, a detailed evaluation based on the performance of these KPIs assesses the project's impact and success in achieving its objectives. This final evaluation measures outcomes and sets a quantifiable benchmark for future innovations in safety and sustainability aspects across diverse industries. This benchmark paves the way for continuous improvement and strategic advancements in the field.

5.1 Dimensions Presentation

For balanced sustainability, MAGNO's KPIs are divided into four dimensions: (I) Environmental, (II) Economic, (III) Social and (IV) Others. Environmental dimension KPIs encompass all project actions that are directly or indirectly related to the environment, as well as the desired final impacts. All the technologies explored in MAGNO will have an economic impact on the process and the value chain to which they belong. Therefore, it is crucial to link all KPIs directly or indirectly to the economic dimension.

The social dimension is mainly associated with actions and objectives related to suppliers and consumers and the way in which the topic will be expanded. The fourth dimension "others" relates to KPIs that are not included in the three dimensions of sustainability, but which have an impact on the project. Indicators linked to the development of technologies and the construction of the Digital Twin are included in this dimension.

The KPIs will be validated by building circular approaches in the digital twin (T2.5 and T2.6). Evaluation and measurement can be assessed using: (I) the LCSA and digital twin and (II) direct measurement of the work and actions carried out. The development of the activities of each associated task will determine the set of data needed for measurement and the best way to do it. In addition, when necessary, they can be obtained from the data made available by the different multi actors who will be contacted during the project.

5.1.1. Environmental

Environmental dimension KPIs measure impacts on terrestrial, marine, or atmospheric environments, both directly and indirectly. It is related to the relevant emissions, the resources consumed, and the related environmental and health impacts. This is essential because, by the year 2030, all the packaging on the EU market must be reusable or recyclable in an economically viable manner.

Thus, it is essential to assess and measure the environmental impacts on the EU market [33]. In this sense, the KPIs within the MAGNO project directly relate to the actions that arise from each stage of Pr-CA. Therefore, the project is evaluating the impact of the project's actions on the value chain, with a focus on assessing the environmental applications of circularity. In addition, the aim is to identify and classify the actions and materials associated with packaging plastics that can harm human health and the environment.

5.1.2. Economic

Economic dimension KPIs aim to measure the economic efficiency each stage brings to the value chain from market stakeholders' perspectives. KPIs should validate and guide progress in developing circularity approaches for the plastic packaging value chain involving

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producers, consumers, and stakeholders. Implementing proposed actions is only feasible when viable solutions for market application and continuity are provided.

The MAGNO project, within the scope of WP6, will develop in-depth work on the analysis of the current European market. To facilitate new business model development and market measurement, it will consider three distinct project stages: the beginning, middle, and end. The market measurement will be essential for the implementation of the circular business approaches that will be defined in WP 3, 4 and 5 and validated in WP2. To this end, during the activities intended to develop a financial projection analysis. Evaluation of the revenue model profitability will help identify future investment needs and define potential cash flow in the food packaging value chain.

5.1.3. Social

Although the correlation between the social dimension and the packaging sector may not be as evident as with environmental or economic dimensions, its importance is significant. The UNEP 2020 Guidelines and the 2021 UNEP Methodological Sheets played a pivotal role in elucidating and standardising them within the MAGNO project [29] [34]. Consequently, the evaluation of the social perspective now entails utilising appropriate impact subcategories, indicators, and measurement units tailored to each stakeholder.

The selection of social KPIs in the MAGNO project was guided by the project's Specific Objectives (SOs). As a result, the social dimension was integrated across 16 KPIs. In this context, emphasis is placed on engaging both consumers and value chain actors, namely suppliers, in a more sustainable food packaging sector. The data and actions linked to these KPIs, and their tasks are meant to encourage more environmentally conscious behaviour and sustainable responsibility among producers and consumers.

5.1.4. Others

The KPIs related to the fourth dimension are mainly related to the development of the digital part of the project and managing their effectiveness. This dimension will link to both the development of the Digital Twin and the evaluation of the technical parameters' performance. This dimension focuses on identifying and quantifying the benefits offered by MAGNO-linked technologies. These benefits aid in constructing circular approaches and benefit associated stakeholders.

6. Results and Discussion

The table of KPIs was developed using the framework presented in the *Table 3*. *Table* ,*Table 6.*,*Table* and, *Table* correspond to the development of the "what", "where" and "who" questions. *Table* , *Table* , *Table* and,*Table* are associated with "how" and "how many". *Table*, with "when". The "why" question is linked to the objectives of developing the KPIs, which are discussed throughout this deliverable.

The results are structured considering the 4 dimensions described in section 5. The results generated make direct reference to the structuring of the initial KPIs and their targets that will be used to measure the results of the MAGNO project. During the project, if new indicators are identified, the KPI table can be updated. The update will be indicated in section 6.5, with the timetable and the person responsible duly indicated.

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6.1 Environmental

Table shows the KPIs that will be used in the MAGNO project, and which are associated with the environmental dimension. The table is constructed following the framework presented in *Table 3*, linking each KPI with its acronym, description ("what"), associated area and task ("where"), and responsible partner ("who").

Table 4. Description of the KPIs in the Environmental dimension.

Acronym	Description	Associated area	Task	Responsible
Kp1	Number of the most dangerous chemical substances and their main uses to define how they pollute soil, water, and air in three environments: terrestrial, freshwater, and marine	Health and Safety	4.1 4.2	UOB
Kp2	Reduce the amount of microplastics produced by packaging	Raw material	3.1	CETEC
Kp3	Reduce the amount of conventional plastic used	Raw material	3.1	CETEC
Kp4	Increase the quantity of biomaterials used	Raw material	3.1	CETEC
Kp5	Number of actions to mitigate and adapt to current and future scenarios in the food packaging value chain	General	-	IDE
Kp7	Developments of novel approaches to reduce plastic impacts on human health	EoL	5.5	HOL
Kp8	Number of different implementations of EoL strategies for plastic packaging	Waste management	3.4	CETEC
Kp9	Increase the total recovery of plastic packaging through recycling (chemical or mechanical)	Recycling	5.2	CETEC
Kp11	Number of main sectors that will be optimised in the value chain for the food system	General	2.6	IDE
Kp14	Increase the total use of recyclable plastics	Recycling	5.2	CETEC
Kp15	Increase the total use of biodegradable materials	Raw material	3.1	CETEC

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Kp16	Number of suggestions for strategies to increase the total rate of plastic packaging waste collected and sorted	Collecting and sorting	5.1	EUPC
Kp21	Increase the total use of recycled plastics via circular business strategies	New business strategies	5.2	CETEC
Kp22	Reducing the amount of solid waste produced via circular business strategies	New business strategies	3.4	CETEC
Kp23	Suggest strategies to expand the number of alternatives to plastics	Collecting and sorting	5.1	EUPC
Kp25	Suggest strategies to increase the total recycling of plastic packaging	Recycling	5.2	CETEC
Kp26	Suggest strategies to reduce the total of food waste	Retailer	4.3	DNV
Kp27	Suggest strategies to optimise the amount of packaging used	Consumer	6.1.1	EUPC
Kp28	Suggest strategies to increase the total use of reusable packaging	Consumer	6.1.2	HOL
Kp30	Total number of workshops to promote EU actions in the food system	General	-	IDE
Kp39	Number of pathways generated to improve packaging production	Manufacturing	3.5	CETEC

Table outlines the targets for each KPI, along with the preliminary necessary data and actions and target for measurement during the project (related to *Table 3*, 5W2H framework, "how" and "how many" respectively). It identifies responsible parties and associated areas. The values presented are linked to the main objectives and impacts that the MAGNO project aims to achieve in the food packaging system. All the targets and the necessary data have been validated and built together with the entire consortium.

Table 5. Necessary data to measure the KPIs in the Environmental dimension.

Acronym	Target	Preliminary necessary data and actions
Kp1	**≥ 5**	Identification of chemicals with descriptions and key evaluation points
Kp2	**69% - 81%**	Quantity of microplastics produced by plastic packaging; Quantity of conventional plastic packaging produced; Identification of the reduction in microplastics emitted by the raw material studied. Measuring the rate of decrease

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Kp3	**50%**	Quantity of conventional packaging plastics used; Quantity of conventional plastic packaging used; Measuring the rate of decrease
Kp4	**Annual growth rate of 17%**	Quantity of biomaterials used for plastic packaging. Measuring the growth rate
Kp5	**10**	Strategies to reduce the impact of the usage of plastic packaging stemming from the results of WP3 to WP6 (included in the deliverables of the respective WPs) through mitigation or adaptation. Definition of future scenarios of the food packaging value chain obtained from the results of WP3 to WP6. Definition of stages of the sustainable value chain for food packaging, including circular approaches
Kp7	**Submit D5.4**	Strategies and definitions for developing approaches based on the results of WP2 to WP6
Kp8	**≥ 5% related of the current**	Strategies and conclusions based on the results of T3.1, 3.2 and 3.3 for developing waste management strategies
Kp9	**> 55%**	Quantity of plastic packaging recycled. Cost of recycling. Cost of disposing of plastic packaging in landfills
Kp11	**4**	Strategies to reduce the impact of the usage of plastic packaging stemming from the results of WP3 to WP6 (included in the deliverables of the respective WPs) through mitigation or adaptation. Definition of future scenarios of the food packaging value chain obtained from the results of WP3 to WP6. Definition of stages of the sustainable value chain for food packaging, including circular approaches.
Kp14	**> current 5%**	Quantity of current use of plastic packaging recycled. Quantity of plastic packaging recycled after MAGNO project solutions. Measuring the growth rate.
Kp15	**> current 3%**	Quantity of current use of biodegradable materials. Quantity of biodegradable materials used after implementing the MAGNO project solutions. Measuring the growth rate.
Kp16	**Submit D5.1**	Strategies and conclusions based on the results of WP3, 4 and 5 for developing the suggestions and strategies
Kp21	**> 55%**	Strategies and conclusions based on the results of WP5. Validations with digital twin in WP2
Kp22	**12%**	Strategies and conclusions based on the results of WP3; Validations with digital twin in WP2
Kp23	**> 18% per year**	Strategies to increase the collection and sorting of packaging plastics from the results of WP5 and WP6 (with consumers)

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Kp24	**> 17%**	Strategies to increase the recycling of packaging plastics from the results of WP5 and WP6 (with consumers)
Kp25	**> 17%**	Strategies to increase the total of recycling of packaging plastics based on the findings from WP5 and WP6 (involving consumers)
Kp26	**> 50%**	Strategies to reduce the total of food waste in plastic packaging food from the results of WP5 and WP6 (involving consumers)
Kp27	**Submit D6.1**	Number of strategies formulated for the use of packaging; Identification of forms of dissemination
Kp28	**> 24%**	Quantity of recycled plastic
Kp30	**4 workshops**	Specific themes. Timeline. Motivation and impact achieved
Kp39	**At least 6**	Strategies to improve packaging production from the results of WP3 to WP6. Specific data to measure cost reduction, operational efficiency, reduction of emissions and waste, implementation of the use of alternative sources of raw materials, and novel designs

All the targets, as well as the actions and data needed to build them, were assessed, and validated by the MAGNO project partners during the deliverable development phase. During the project's development, primarily in phase (I), knowledge supporting the circular approach and business strategy construction will be mapped and developed. The project may introduce new values and more targeted actions.

6.2 Economic

Table 6 shows the KPIs that will be used in the MAGNO project and that are associated with the economic dimension.

Table 6. Description of the KPIs in the Economic dimension.

Acronym	Description	Associated area	Task	Responsible
Kp8	Number of different implementations of EoL strategies for plastic packaging	Waste management	3.4	CETEC
Kp11	Number of main sectors that will be optimised in the value chain for the food system	Technical	2.6	IDE
Kp12	Number of modern business approaches that will be developed in the food packaging system	New business strategies	6.2	KVC

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Kp13	Total improvement in the incrementation of the business approach	New business strategies	6.2	KVC
Kp16	Number of suggestions for strategies to increase the total rate of plastic packaging waste collected and sorted	Collecting and sorting	5.1	EUPC
Kp24	Creation and increase the number of sustainable brands	New business strategies	6.2	KVC
Kp38	Total efficiency of the new manufacturing routes	Manufacturing	3.3	CETEC
Kp39	Number of pathways generated to improve packaging production	Manufacturing	3.5	CETEC

All the KPIs in the economic dimension are related to the strategies or implementations that MAGNO aims to achieve. Data and developments from MAGNO will undergo validation through the digital twin (T2.5 and 2.6) as outlined in WP2. Additionally, Task 2.3 will provide information. Measurement and validation of KPIs for the circular approach and business plan strategies will rely on completing and constructing these tasks.

Table shows the target, data, and actions that will initially be considered for measuring the KPIs.

Table 6. Target and necessary data to measure the KPIs in the Economic dimension.

Acronym	Target	Preliminary necessary data and actions
Kp8	**≥ 5% related of the current**	Identification of chemicals with descriptions and key evaluation points
Kp11	**4**	Quantity of microplastics produced by plastic packaging. Quantity of conventional plastic packaging produced. Identification of the reduction in microplastics emitted by the raw material studied. Measuring the rate of decrease.
Kp12	**≥ 5**	Quantity of conventional packaging plastics used. Quantity of conventional plastic packaging used. Measuring the rate of decrease.
Kp13	**10%**	Quantity of biomaterials used for plastic packaging. Measuring the growth rate.
Kp16	**Submit D5.1**	Strategies to reduce the impact of the usage of plastic packaging stemming from the results of WP3 to WP6 (included in the deliverables of the respective WPs) through mitigation or adaptation. Definition of future scenarios of the food

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		packaging value chain obtained from the results of WP3 to WP6. Definition of stages of the sustainable value chain for food packaging, including circular approaches.
Kp24	**> 17%**	Strategies and definitions for developing approaches based on the results of WP3 to WP6
Kp38	**6**	Strategies and conclusions based on the results of T3.1, 3.2 and 3.3 for developing waste management strategies. Cycle time of routes, production yield, quantity of waste and products formed, downtime, cost per unit produced, and labour rate
Kp39	**6**	Quantity of plastic packaging recycled. Cost of recycling. Cost of disposing of plastic packaging in landfills.

6.3 Social

The following *Table* shows the KPIs that will be used in the MAGNO project and are associated with the social dimension.

MAGNO's KPIs in the food packaging value chain are deeply intertwined with the social dimension, reflecting a commitment to societal engagement and cooperation. For example, the social dimension plays a pivotal role in KPIs like validating optimal plastic packaging strategies (Kp5) and enhancing public awareness of sustainable packaging (Kp6).

Considering the social dimension will result in significant shifts in the ways that producers and consumers interact with the food packaging industry.

MAGNO's approach to achieving its KPIs emphasizes the interconnectedness of social, economic, and environmental factors in driving sustainable outcomes within the food packaging value chain.

Table 7 Description of the KPIs in the Social dimension.

Acronym	Description	Associated area	Task	Leader
Kp5	Number of actions to mitigate and adapt to current and future scenarios in the food packaging value chain	General	2.6	IDE
Kp7	Developments of novel approaches to reduce plastic impacts on human health	Consumer	4.1 4.2	UOB
Kp10	Number of invitations from European and international entities to engage in	General	2.3	DNV

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	MAGNO's activities and include the multi-actor approach			
Kp17	Increase the amount of producer responsibility	New business strategy	-	IDE
Kp18	Encourage an increase in the total use of biomaterials	Raw material	6.1.2	HOL
Kp19	Encourage increased recycling and reuse	Recycling	6.1.2	HOL
Kp20	Promote the decrease in the quantity of materials utilised in new designs	Product design	6.1.2	HOL
Kp27	Suggest strategies to optimise the amount of use of packaging	Consumer	6.1.1	EUPC
Kp29	Increase the amount of educating for employees and consumers	Consumer	6.1.2	HOL
Kp30	Number of workshops to promote EU actions in the food system	General	-	IDE
Kp32	Raising awareness to encourage consumption of more sustainable packaging	Consumer	6.1.1	EUPC
Kp33	Monitor over time the consumer's behaviour to repeat newly acquired sustainable buying habits	Consumer	6.1.1	EUPC
Kp34	Meetings and networking events with stakeholders to showcase and discuss the solutions provided to foster the SMEs adaptation to EU level legislative requirements	General	4.4	EUPC
Kp41	List of action plans for correct discard	Consumer	6.3	KVC
Kp42	List of actions to promote non-use of packaging	Consumer	6.3	KVC

Table below outlines the essential preliminary data and actions required for the project's initial stages. These data and actions are subject to adaptation and refinement as the project progresses, ensuring flexibility and adjustment in response to evolving circumstances and insights.

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Table 8. Target and necessary data to measure the KPIs in the social dimension.

Acronym	Target	Preliminary necessary data and actions
Kp5	**2 actions (multi-actor list and workshop)**	Multi-actors list. Workshop timeline.
Kp7	**Submit D4.1**	In addressing the health and safety aspect later on in the deliverable, it becomes imperative to gather pertinent data regarding consumer well-being concerning plastic usage and exposure to address the health and safety aspect. Educative strategies to advocate for community accountability in the plastic packaging sector
Kp10	**50 actors**	List of 50 target actors from various facets of the food ecosystem. Relationships among stakeholders through open communication channels and transparency
Kp17	**Kp14+Kp15+Kp16= >12%**	Build a scale to calculate the metric result of Kp14, together with Kp15 and Kp16 to measure Kp17, as it is the result of the success of all other three KPs
Kp18	**1 activity**	Outline actions to encourage the increase of the total use of biomaterials
Kp19	**1 activity**	Outline activities to encourage the increase of the % of recycling of current plastic packaging
Kp20	**1 activity**	Outline actions to encourage the increase of the % of current novel designs
Kp27	**2 actions (general survey + focus group)**	Efforts to increase public commitment through general surveys and focus groups
Kp29	**2 actions (educative training/workshop and awareness)**	Delineate education and awareness actions.
Kp30	**13 workshops**	Outline specific themes. Determine timeline. Analyse achieved impact
Kp32	**Submit D6.1**	In addressing the health and safety aspect later on in the deliverable, it becomes imperative to create consumer engagement through feedback channels such as site visits, interviews, and surveys. Analyse consumers' preferences and receptiveness towards

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		sustainable packaging initiatives. Commitment to transparency
Kp33	**Submit D6.1**	In addressing the health and safety aspect later on in the deliverable, it becomes imperative to create consumer engagement through feedback channels such as site visits, interviews, and surveys. Analyse consumers' preferences and receptiveness towards sustainable packaging initiatives; Commitment to transparency
Kp34	**3 meetings**	Description of meetings. Description of content presented and discussed
Kp41	**Submit D6.6**	Number of activities executed by the end of the task. Number of participants. Companies involved in these activities or adhere to the action plan. Consumer self-perception declared in surveys
Kp42	**Submit D6.6**	Number of activities executed by the end of the task. Number of participants. Companies involved in these activities adhere to the action plan. Consumer self-perceptions declared in surveys

According to the results of the table, these KPIs emphasise inclusive strategies and innovative approaches to mitigate environmental impact and foster sustainability.

Overall, the main actions of these KPIs focus on collaboration, communication, and transparency. Activities such as engaging diverse stakeholders (Kp10) and fostering robust supplier relationships (Kp12) underscore the importance of open communication channels and dynamic exchanges of ideas. Additionally, initiatives like developing a consumer acceptance web platform (Kp31) and organising workshops to promote EU actions (Kp30) emphasise the role of transparent communication with stakeholders.

Besides that, through tasks like involving multi-actors and establishing feedback mechanisms, MAGNO seeks to unite decision-making policies and nurture international cooperation. This ensures that strategies align with societal needs and aspirations.

6.4 Others

The "others" category is associated with indicators directly related to the technologies used and created in the MAGNO project, as previously stated. In this sense, KPIs associated with the consumer web platform, NPL, and Digital Twin, among others, will be within this category. *Table* shows those KPIs that will be used in the MAGNO project and that correspond to the "others" category.

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Table 9 Description of the KPIs in the Other category.

Acronym	Description	Associated area	Task	Leader
Kp6	Number of inclusions of circular approaches to be used in the consumer web platform	General	5.5.	HOL
Kp12	Number of modern business approaches that will be developed in the food packaging system	New business strategy	6.2.2	KVC
Kp31	Creation of a consumer acceptance web platform	Consumer	6.4	IRIS
Kp35	Effectiveness of information extraction by NLP	General	2.2	IDE
Kp36	A complete and FAIR database ready to use	General	2.4	IRIS
Kp37	The accuracy of the digital representation between the data and the real system	General	2.5	IDE
Kp40	Number of roadmaps to be used in the packaging industry	General	4.5	UOB

Table below shows the target, the data and actions that will initially be considered for measuring the KPIs in the "Other" categories. These KPIs will be accessed throughout the project, especially from WP2 to WP6. As stated before, it's crucial to remember that as the project develops, these facts and activities could either change or be improved.

Table 10 Target and Necessary data to measure the Other KPIs

Acronym	Target	Preliminary necessary data and actions
Kp6	**5**	Acquire the necessary data. Establish a timeline for the development of these circular approaches. Quantify public commitment to sustainability issues through feedback mechanisms (i.e., interviews and surveys)
Kp12	**≥ 5**	Feedback mechanisms, such as site visits, for a consumer-centric approach
Kp31	**1**	Development of a comprehensive consumer acceptance web platform. Integration of data gathered across various work packages, spanning from WP2 to WP6. Feedback mechanisms

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Kp35	**70 - 90%**	European analysis reports, roadmaps and scientific articles regarding food plastic packaging and the food packaging value Chain. Strategies to reduce the impact of the usage of plastic packaging stemming from the results of WP3 to WP6 (included in the deliverables of the respective WPs) through mitigation or adaptation. European analysis reports, roadmaps and scientific articles regarding food plastic packaging and the food packaging value Chain. Strategies to reduce the impact of the usage of plastic packaging stemming from the results of WP3 to WP6 (included in the deliverables of the respective WPs) through mitigation or adaptation. Definition of future scenarios of the food packaging value chain obtained from the results of WP3 to WP6. Definition of stages of the sustainable value chain for food packaging, including circular approaches.
Kp36	**1**	General structure for the database
Kp37	**70 - 90%**	Value of the mean absolute error between the reference data and those obtained via digital twin
Kp40	**> 6**	Development of the work carried out in WP3 - 6 and validation in WP2

6.5. Updating and validation

Results monitoring will be carried out to update progress in relation to the KPIs developed (related to *Table 3*, 5W2H framework, "when"). Updates will be monitored by the project coordinator through Task 2.5 and validated through Task 2.6 and tasks developed in stage (II) of the project. KPIs and necessary validation actions will be adjusted in response to new insights or external factors, managed within the relevant tasks. *Table* shows the suggested schedule for verifying the KPIs.

Table 11 Timeline for updating the KPIs.

Time	Objective	Responsible	Action
M6	Deliverable 1.3 submission	HOL	Prior validation by all partners.
M31	Update	IDE Task 2.5	Evaluate the progress of the MAGNO project considering the targets proposed in the KPIs. Re-evaluation, if

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			necessary, of the data and KPIs in the deliverable.
M40-M42	Final evaluation	IDE	Final evaluation to compare the results obtained and achieved by the MAGNO project.

As shown in the last row of the table, at the conclusion of the project, a detailed evaluation based on the performance of these KPIs assesses the project's impact and success in achieving its objectives. At the project's conclusion, a detailed evaluation based on KPI performance assesses its impact and success in achieving objectives, as demonstrated in the last row of the table. This benchmark paves the way for continuous improvement and strategic advances in this field.

7. Conclusions

This deliverable has detailed the development and implementation of a comprehensive KPI framework for the MAGNO project. It has systematically identified, refined, and quantified KPIs aligned with the project's objectives, ensuring that they accurately measure and reflect the intended outcomes. These tailored KPIs assess diverse project aspects, including environmental, economic, social and other dimensions, fostering a balanced and holistic project evaluation approach.

In summary, MAGNO aims to empower communities, influence policy updates, and shape the packaging sector's trajectory towards sustainability by integrating social dimensions and fostering collaboration.

The implementation of this KPI framework is instrumental in driving the project towards its strategic goals, allowing for ongoing assessment and real-time adjustments. This dynamic approach ensures adherence to initial objectives while adapting to new challenges and information, enhancing project agility and effectiveness overall.

From the work developed, further refinement of the KPI framework to ensure even greater integration with emerging project needs and external developments could be necessary. Furthermore, there's a sustained effort to share outcomes and lessons learned from KPI implementation with broader stakeholders, encouraging wider adoption of best practices. Future research could examine how these KPIs influence long-term project sustainability and success, potentially extending the framework to align future projects with MAGNO innovations.

The KPI-focused approach streamlines project management and sets a benchmark for future initiatives, highlighting the critical role of effective KPIs in achieving project excellence. Insights here emphasize the transformative potential of structured KPI management, promising substantial contributions to the field and inspiring continued advancement and application of these practices.

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