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MONSOON

MOdel based coNtrol framework for Site-wide OptimizatiON of data-intensive processes

D7.1 – Initial evaluation framework

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Executive Summary

This document aims at providing the initial specifications for the evaluation framework; this is a set of KPIs that allows to quantify the benefits of the application of data-driven optimization methodologies from several perspectives (environmental, industrial, cross-sectorial and circular economy).

A brief introduction gives the overview of the document, as well as basic information about the context. Focus is set on the rationale behind the evaluation framework, providing a detailed description of its purposes, its structure and the selected KPIs.

Chapter 1.1 contains information about aluminium domain. For the relevant use cases, the most significant domain-specific KPIs are listed and explained. The same approach is adopted in Chapter 0 concerning plastic domain.

In Chapter 4, outcomes from the analysis of both domains are merged. A multilayer structure is defined for the evaluation framework: a base layer which contains cross-sectorial KPIs shared by both domains and a customized layer where domain-specific KPIs are stored.

Chapter 0 provides an example of application of the evaluation framework with the KPIs already available at this stage of the project. For this iteration, the indicators included in this section are coming from offline calculations performed by LCEN and other data scientist MONSOON partners.

Chapter 6 draws some preliminary conclusions about the initial evaluation framework. Most promising directions for next steps and improvements are identified and a list of actions to be taken for the final version is drafted.

1 Introduction

This document is the first official output from task 7.1 in the MONSOON project. The task is part of WP7, which is devoted to identifying tools to evaluate the effectiveness of the application of data-driven optimization methodologies developed by data scientist within other tasks of the project.

Goal of this document is to present the preliminary specifications for the evaluation framework. This component is made of a collection of KPIs, clustered in different sections according to the nature of each of the selected indicators; with such a division, the evaluation framework allows to quantify the benefits from several perspectives, from the environmental one to the process one, from the cross-sectoriality one to the circularity one.

This deliverable is published at the half of the project (month 18) and a first list of KPIs can be listed to populate the evaluation framework; the ultimate version of this matrix will be described in the final deliverable, expected by month 30. In particular, final version will include elements to evaluate the replicability and the scalability of the MONSOON platform in other industrial domains; as this initial version is based on results and achievements related to iteration 1[1], no specifications are still available concerning usability and scalability.

The KPIs included in this deliverable are classified into different clusters to better address the evaluation of the platform according to the chosen perspective:

- ***Domain-specific KPIs***: this class includes all the indicators that are used to quantify the onsite effectiveness of the optimization functions. As a general consideration, these KPIs can't be cross-sectorial due to their high connection with the specific use cases and cannot be transferred to other domains (unless in case of particular conditions of technological similarity);

- ***Environmental KPIs***: this class includes all the indicators employed to quantify any environmental impacts. These figures are used to quantify either the local and the global footprint related to the investigated process; typical examples of environmental KPIs are the total greenhouse gases emission, the use of resources, water consumption. These KPIs present high cross-sectoriality, as they can be used to evaluate the environmental impact of a wide range of manufacturing processes;

- ***Circularity KPIs***: this class includes KPIs related to quantify the circularity[2] of the product along its life cycle. Even if no certified methodologies are available so far to compute this family of indicators, a customised metric has been developed by LCEN to evaluate circularity figures in the MONSOON project. These KPIs will be described even though a complete application is likely to occur in the second iteration of the project;

- ***Replicability KPIs***: this class includes KPIs which are not related to the process but to the MONSOON platform itself. For their own nature, these KPIs such as usability, scalability and replicability will be documented in *D 7.2 - Final Evaluation Framework* (expected month 30), where the easiness of deployment of the platform in other industrial contexts will be assessed.

Next chapters describe the selected use cases for aluminium and plastic domains that have been used to feed the evaluation framework during iteration 1. For each use case, a brief description of the process-specific KPIs is presented. After these domain-specific analysis, a complete map of the selected KPIs will be

[1] MONSOON adopts an iterative approach to deploy components and validate algorithms. According to this approach, the term "iteration" defines the two halves of the project; along this document "iteration 1" will identify the first period (M1-M18)

[2] "In a circular economy, the value of products and materials is maintained for as long as possible. Waste and resource use are minimized, and when a product reaches the end of its life, it is used again to create further value. This can bring major economic benefits, contributing to innovation, growth and job creation" [Source: European Commission]

presented in chapter 4, along with some considerations regarding the nature and the rationale behind each of the selected indicators.

1.1 Related documents

ID	Title	Reference	Version	Date
[RD.1]	Initial Runtime Container	D 3.7	1.0	2017-11-30
[RD.2]	Initial Online and deep machine learning techniques	D 5.3	2.2	2018-01-08
[RD.3]	Initial Life Cycle Management plugin	D 5.7	1.2	2017-12-22

2 Aluminium domain

This chapter describes the use cases selected for iteration 1 in the aluminium domain. A description of the process is provided, as well as some specifications related to the nature of process KPIs computed by data scientists.

2.1 Identified use cases for iteration 1

Anodes affect significantly the quality of the aluminium produced in the electrolysis pot; therefore, bad quality anodes may have a major impact on aluminium production cost. By reducing the variability and improving the control of the anode quality, we anticipate a decrease of the anodic incidents in the electrolysis pot (in particular, anode effects and mushrooms).

The anode assembly (called from now on along the document *anode*) that is introduced in the pot is the final product of the carbon area. This area is divided in 3 main workshops which have specific functions:

- The paste plant produces green anodes from calcined petroleum-coke, coal-tar pitch and recycled scraps and anode butts by mixing, forming and vibrocompaction;

- These green anodes are baked to obtain the mechanical and electrical properties of the anodes sought for the electrolysis reaction. This step is realized in the baking furnace;

- Finally, the baked anodes are sealed to metallic stem in the anode rodding shop to form the said anode assembly. Figure 1 represents the process flow to produce green anodes ready for electrolysis line:

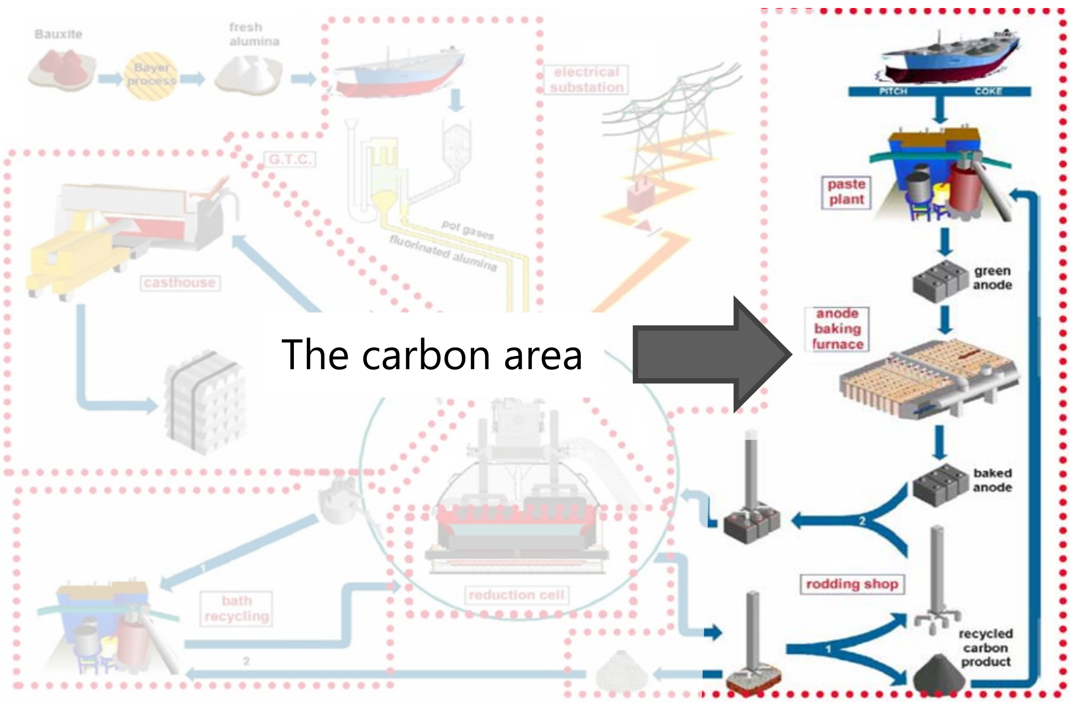

Figure 1 – The carbon area

The anode quality is greatly influenced by the variability in equipment running settings and their stoppages. Some relations between equipment settings variation, raw material recipe and anode quality are already known. But some are not yet discovered and need to be controlled.

During the first iteration of MONSOON, we focused on the green anode production process as illustrated in Figure 2. The MONSOON project will help, thanks to the predictive functions under development, to understand the real-time impact of the equipment deviation from nominal setting or of the process parameters variability on the green anode quality and, when possible, trigger alerts to implement the correct settings or conditions to obtain the expected anode quality.

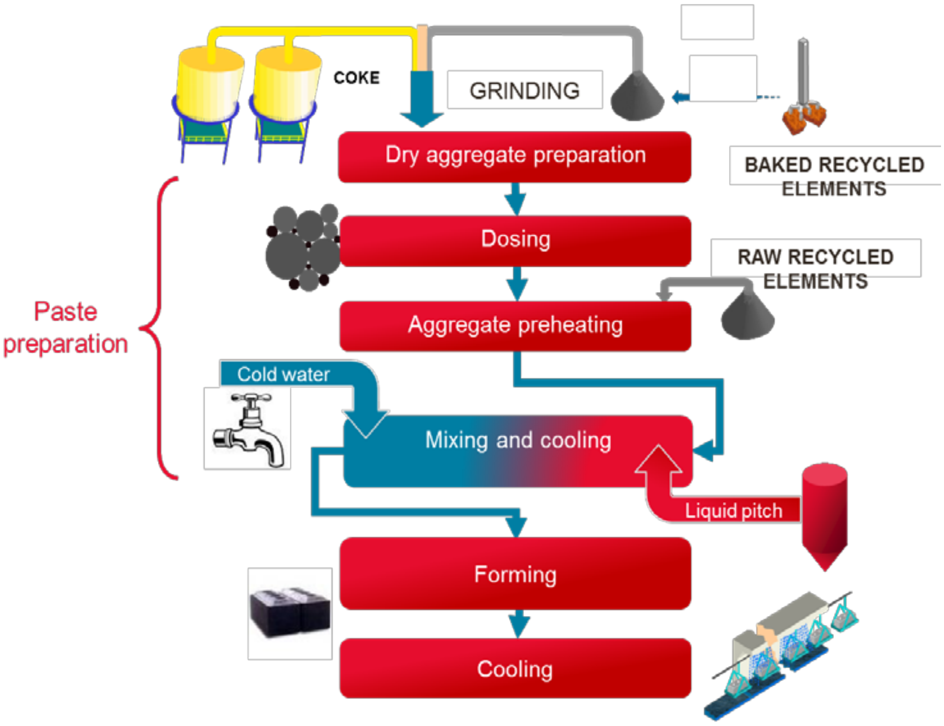

Figure 2 - Anode production process

During the first half of the project, we identified and selected about 80 relevant process variables coming from onsite monitoring equipment, coming from the different machines of the chain depicted in the flowsheet diagram. These inputs were used to predict the anode density that is one of the most relevant KPIs we have defined for this use case (see 2.2.1).

Note: This prediction on anode quality may be improved by the predictive maintenance function that we have planned to study in parallel to this first predictive function in the coming months. Results of this application will be included in the final version of this deliverable.

2.2 Identified KPIs for aluminium domain in iteration 1

2.2.1 Domain-specific KPIs

For the first iteration, as we focused on the green anode production, two different process KPIS have been identified:

- o green anode density variability;
- o anode rejection rate.

The variability of the green anode density affects their behaviour on the pots and can lead to instability of the pot and to anodic incidents.

Any rejected anode is reintroduced in the green anode production process. The anode blocks are crushed in a specific workshop to a required dimension before being reintroduced as green recycled product. Even if the impact of raw material is reduced thanks to the internal recycling process, this specific step is energy consuming and leads to inefficiencies along the production process.

For iteration 1, we are working on batches of anodes produced per 30 minutes periods. A period is considered of lower quality if at least one anode produced has a density below 1620 kg/m^3. The KPI is therefore the number of such lower quality periods.

The variables, measured in the paste plant, which were found to be the most important for this KPI were the following:

Table 1 - List of considered variables for the anode density

Tag name	Variable[3]
D110-M120_DEPRESSION_FILTRE,	M120 filter (for condensers) underpressure
D110-J030_VIT_MOT_VIS_DEMANDEE,	J030 dosimeter screw requested velocity (medium silo)
D110-J020_VIT_MOT_VIS_DEMANDEE,	J020 dosimeter screw requested velocity (under coarse silo)
D110-J030_DEB_INSTANTANE_DOSEUR,	J030 dosimeter instant flow (medium silo)
D110-J010_VIT_MOT_VIS_DEMANDEE,	J010 dosimeter screw requested velocity (under very coarse silo)
D110-J173_DEB_EAU_REFROIDISSEMENT_J173,	J170 cooler water flow
D110-J050_DEB_INSTANTANE_DOSEUR,	J050 dosimeter instant flow (fines silo)
D110-E180_MES_NIV_SILO_CLASS_FINES,	Fine silo level
D110-J080_DEPRESSION_FILTRE,	J080 filter (magnetic separator) underpressure
D110-J010_DEB_INSTANTANE_DOSEUR,	J010 dosimeter instant flow (under very coarse silo)
D110-SL3_MES_NIVEAU_MOYEN_SILO,	coke mixture silo SL3 level
D110-J160_INT_MINI_MALAXEUR,	J160 Buss mixer minimum intensity
D110-J170_NIVEAU_MELANGEUR_REFROIDIS,	J170 cooler paste level
D110-E150_DEPRESSION_FILTRE,	Turboseperator (TSV) dedusting filter E150 underpressure
D110-J172_INT_MOT_TOURBILLON,	J170 cooler tool motor intensity
D110-J160_INT_MOY_MALAXEUR,	J160 Buss mixer mean intensity
D110-K070_VIT_VIBRATION,	K070 control group for vibrocompactor K050_vibrating velocity
D110-J050_VIT_MOT_VIS_DEMANDEE,	J050 dosimeter screw requested velocity (fine silo)

[3] The code *J[number]* before the variable name identifies the part of the production chain the variable comes from

D110-E120_NIVEAU_BRUIT_BROYEUR,	Noise level from sensor E120 for the Ball Mill E100
D110-K060_VIT_VIBRATION,	K060 control group for vibrocompactor K040_vibrating velocity
D110-J160_MES_CORRIGE_TENDANCE_BOUR,	J160 Buss mixer intensity for the indication of jamming
D110-J160_VIT_VIS_MALAXEUR,	J160 Buss mixer screw velocity
D110-J160_INT_MAXI_MALAXEUR.	J160 Buss mixer maximum intensity

2.3 Glimpse of the use cases to be addressed during iteration 2

During iteration 2, we will go deeper in the green anode quality study, to predict the individual green anode (whereas in iteration 1 we can only achieve batch quality prediction). We might extend the scope to the prediction of the maintenance to other machine of the paste plant.

For this additional study in the carbon area, the KPI are similar to the ones defined during iteration 1; namely, the computed KPI will be the anode density and the good/bad classification will be driven by the same criteria as reported above.

Furthermore, in the electrolysis area, we would like to study the impact of process parameters on the liquid heights (molten metal and bath) and eventually the pot thermal balance, thanks to the data provided by a mechanical sub-part of the pot, the chisel, which delivers the mix of fluorinated alumina and bath needed for the electrolysis reaction.

For this new study, the following KPIs might be assessed:

- The pollution of the metal by the iron coming from the pins of the anode assembly that might be attacked by the bath if the volume of liquids is out of range;
- The current efficiency because of bath chemistry deviations.

These KPIs might be updated in *D 7.2 - Final Evaluation Framework.*

3 Plastic domain

3.1 Identified use cases for iteration 1

In the plastic domain we considered injection moulding process industries to implement the concept of MONSOON.

The injection moulding production technology has emerged as the main vehicle to produce highly complex, precise, value-added commercial parts with tight tolerance and surface finish. Almost 90% of the total high-tech polymer materials production is processed by injection moulding. The actual market is very demanding, and the production of plastic pieces is changing from a low-quality mass production to high quality injection processes, where the pieces obtained must comply with rigorous quality tests. The characteristics of a certain piece do not depend only on the raw material, but also on the transformation process. Therefore, it is convenient to carry out an exhaustive control of the injection process, controlling all the parameters present in this process. The process of plastic injection is based on melting a plastic material and make it flow inside a mould, where a cavity is filled up, obtaining various forms that allow obtaining a wide variety of products. In the following figure, there is a schema of an injection machine, where the three main parts of these machines are specified.

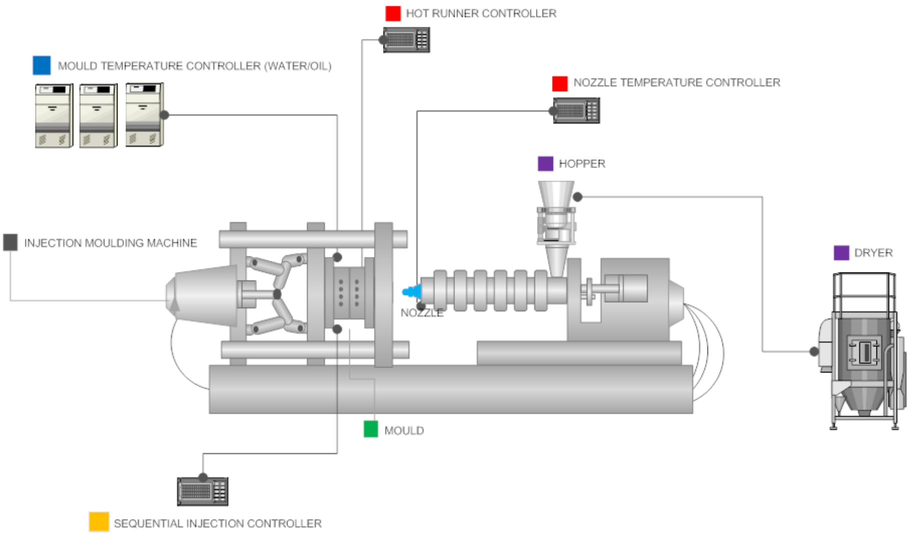

Figure 3 - Schematic of an injection moulding production cell and related equipment layout

For the MONSOON project we have selected two different business cases:

1. **Coffee capsules:** a very high productive case with a low part complexity;

2. **Automotive parts:** a very technical part, with intricate details but a low productive cadence.

For this we expect the MONSOON approach leads us to several enhancements related to:

- **Resource consumption:** for companies in this market a reduction in resource consumption can be achieved by reducing the number of scraps and maximizing their recycling in the same production process;

- **Products quality:** the combination of several factors affects product quality. Most significant parameters to be adjusted are the geometry of materials, the lubrication required, the injection temperature, the mould temperature, the injection pressure, the number of injection cycles and the compulsory dimensional tolerances; their optimization is expected to lead to more efficient production;

- **Decrease of the non-OK parts:** this can be achieved by acting on maintenance and moulding parameters setup. Today, the process is manually repeated until the machine starts to produce parts at desired quality level, producing an indefinite number of poor-quality product or even waste. This process could be sensibly optimized through a predictive model, allowing the production management to evaluate the optimal parameters for a more efficient injection process and waste decrease;

- **Mould process problems solving:** if a non-quality product is spotted, the corresponding machine/mould must be stopped until the problem is solved. The problem can be the consequence of a severe issue (e.g. mould damaged or broken); the proper repair or substitution might take up to three weeks. Thanks to the MONSOON approach, a specific problem can be recognized by large scale data analysis, reducing the number of wasted parts produced; the repair operations can be immediately triggered as well.

The impacts for the European plastic industries exploiting the MONSOON innovation are potentially extremely relevant, such as:

- **Overall financial value at stake, and industry sustainability:** based on three main types of predictive functions: predictive maintenance (Asset Health Management), process optimization (on all injection processes: power, fusion, compression, injection) and predictive quality (on the injection parameters definition: temperature, injection speed, and temperature), the MONSOON project, will allow the Production Management Teams to implement through large scale data collecting and real-time analysis, the algorithms which will maximize the company value;

- **Social Impacts:** under the current European conjecture, the plastic represents almost a nowadays dependence and the growth of the plastics industry affects several sectors of the European economy. The plastics industry is a key to the innovation of many products and technologies in other sectors like healthcare, energy generation, aerospace, etc. In other hand the plastics can assume a leading role as a strong contributor to a more environmentally sustainable and resource efficient Europe.

3.2 Identified KPIs for plastic domain in iteration 1

3.2.1 Process KPIs

For the first iteration we have focused on the business case 1 and all the consumption factors associated, namely the raw material consumption, parts quality control (OK vs NOK parts) and the corresponded waste that is generated as well as the energy consumption.

Despite the business case 1 has a 2% rejection rate for the produced parts, there is still room for improvement: less process stoppages, less mould faults/errors, decrease of the energy consumption based on optimized injection setups and less waste production.

Business case 2 will be evaluated during the second half of the project. KPIs selected for coffee capsules production will be re-evaluated to assess whether they can be used or not for this second iteration.

Next chapter provides details about how the process-specific KPIs described in chapters 2 and 3 are merged with cross-sectorial KPIs into the evaluation framework.

4 Evaluation framework structure

In this chapter, the use case knowledge which has been detailed in previous two sections is used to populate the first version of the evaluation matrix for the MONSOON project. Each indicator is characterized by its name, class, measure unit, KPI source and a description of the rationale behind it. It must be noticed that detailed description of the mathematics behind the computation of each indicator is out of the scope of this deliverable, for several documents have been issued by the MONSOON consortium regarding this topic. In addition to the previous consideration, the goal of this deliverable is to describe the rationale behind the chosen KPIs. Additional information can be retrieved from the documents reported in 1.1.

The evaluation framework is divided in two different blocks: a common layer where cross-sectorial KPIs are reported, and a domain-specific layer, where indicators that are relevant just for some use cases are stored. The combination of these two layers provides the initial version of the evaluation framework for the MONSOON project at the end of iteration 1.

An additional disclaimer needs to be mentioned about Environmental KPIs: these indicators are computed referring to a *Cradle to Gate* perspective; this means that they account for impacts generated directly by the process (such as the combustion of fuels or the emissions to air) and impacts generated in the upstream (such as the mining of materials). Whenever this perspective is not adopted for an Environmental KPI, it is mentioned in the description of the indicator; otherwise, it shall be assumed that the *Cradle to Gate* perspective is adopted.

4.1 Base layer

Table 2 - Evaluation framework: base layer

KPI name	Unit	Origin	Class	Description
Global Warming	kg CO_2 equivalent	LC management plugin	Environmental	Total amount of equivalent greenhouse gases generated by the investigated process
Primary Energy Consumption	MJ equivalent	LC management plugin	Environmental	Total amount of primary energy required to manufacture the investigated product
Direct Energy Consumption	MJ equivalent	LC management plugin	Environmental	Total amount of energy (electric and thermal) directly consumed by the investigated process
Electricity consumption	MJ	LC management plugin	Environmental	Total amount of electricity directly consumed by the investigated process
Raw material consumption	kg	LC management plugin	Environmental	Total amount of material required to manufacture a unit of valuable product
Recycled content	%	LC management plugin	Environmental - process	Percentage of recycled material in the investigated product
Water Consumption	l	LC management plugin	Environmental	Total amount of water required to manufacture the investigated product
Waste to landfill	kg	LC	Environmental	Total amount of waste originated from

		management plugin		the process which manufactures the investigated product and sent to landfill
Waste to recycling	kg	LC management plugin	Environmental	Total amount of waste originated from the process which manufactures the investigated product and sent to recycling
Process yield	%	LC management plugin	Process	Ratio between the valuable output of the investigated process and the total input material
Product Circularity Index	%	to be defined	Circularity	Grade of circularity of the investigated product along its whole life cycle

The base layer is mainly composed of Environmental KPIs: this is a reasonable configuration, for the Environmental class shows high cross-sectoriality. The selected indicators have been chosen according to a reliability criterion, which favoured KPIs with high robustness concerning the impact assessment method and the characterization factors to be adopted. All the Environmental KPIs are computed by the Life Cycle Management plugin implemented within WP5 activities; further information concerning this component is available in [RD.3].

The only process KPI included in the base layer is the process yield. This is because each process is expected to experience an increase of its yield due to the adoption of optimization techniques. Process yield is computed as a by-product of the LC plugin, as the evaluation of the yield is a required step in the process to compute Environmental KPIs.

The Product Circularity Index expresses "how much" the product is circular along its life cycle. This parameter is computed by means of a dedicated metric based on circular economy theories. At this stage of the project, this KPI is not computed for aluminium domain; this is because in this iteration the focus was on the anode production, which is a mid-product which function is to feed the electrolysis process which originates the aluminium product. For plastic use case the indicator has been computed offline with LCEN tools for demonstration purposes.

4.2 Domain layer: aluminium

Table 3 – Evaluation framework: domain layer (aluminium)

KPI name	Unit	Origin	Class	Description
Anode quality	number of low quality batches	Dedicated predictive function	Process	Anode quality is evaluated referring to anode density; according to the computed density value, a batch of anodes is annotated as *good* or *bad*
Anode rejection rate	%	Dedicated predictive function	Process	Rejected anodes need to be recycled, with extra consumption of energy and machinery due to the crushing and re-forming processes
Acidification Potential	kg SO_2 equivalent	LC management plugin	Environmental	Potential of acidification and creation of acid rainfall arising from the production

				of the green anode
Natural gas consumption	MJ	LC management plugin	Environmental	Total amount of natural gas directly consumed by the investigated process

4.3 Domain layer: plastic

Table 4 - Evaluation framework: domain layer (plastic)

KPI name	Unit	Origin	Class	Description
Rejection rate	%	Dedicated predictive function	Process	Percentage of waste capsules produced

5 Evaluation Framework application

This chapter presents an example about how the evaluation matrix depicted in the previous sections could be populated once the MONSOON platform will be implemented. At this stage of the project, not all the components required to compute the KPIs are available online; due to this constraint, the reported indicators have been computed offline by LCEN and other data scientist partners using algorithms and techniques that will be replicated online in the dedicated components of the platform. Some specifications about these components are available in [RD.1], [RD.2] and [RD.3].

Goal of this section is not to provide ultimate and validated results, but to give a glance about how the Evaluation Framework could work at the end of iteration 2 of the project. In particular, what is missing in the following representation is a baseline scenario to be used as a benchmark for the quantification of the actual benefits arising from the application of the MONSOON methodology. The massive amount of site data from both domains which has been retrieved during iteration 1 will be used to build up the baseline scenario to be used in iteration 2. Following this consideration, Final Evaluation Framework is supposed to contain a dedicated dashboard to be used as a monitoring tool for the benefits of the MONSOON application referring to the baseline scenario. Since the baseline scenario has been built within iteration 1, this tool is not described in this version of the Evaluation Framework and its description is not provided in this document.

An additional disclaimer regards the flow to which the KPIs are referred to. This *reference flow* is reported for each indicator in each application of the Evaluation Framework. A representativeness criterion has been adopted for the selection of the reference flow: for aluminium domain, most of the KPIs are referred to a single anode, while for plastic most of the KPIs are referred to one kilogram of produced capsules. It must be noticed that direct comparison of KPIs coming from different domains is out of the scope of MONSOON, which main goal is to provide domain experts with a set of meaningful KPIs to enhance process performances.

5.1 Evaluation Framework: aluminium domain

In this section, an example of Evaluation Framework applied to aluminium domain is reported for iteration 1 of the MONSOON project.

As this is an explanatory representation which aim is not to provide extended results, a sample reference time has been chosen. In particular, reported KPIs are referred to the average green anode production from September 2016 to June 2017.

Table 5 - Evaluation Framework applied to aluminium domain, (average green anode production, from September 2016 to June 2017, Aluminium Pechiney facilities). Green lines represent the base layer, blue lines contain domain-specific KPIs.

KPI name	Reference flow	Unit	KPI value	Comments
Global Warming	Anode	kg CO_2 equivalent	566	
Primary Energy Consumption	Anode	MJ equivalent	60 480	
Direct Energy Consumption	Anode	MJ equivalent	565	
Electricity consumption[4]	Anode	MJ	55	

[4] During iteration 1, only mixer electricity has been considered in the analysis

Raw material consumption	Anode	kg	1082	
Recycled content	Anode	%	26,1	
Water Consumption	Anode	l	5 400	
Waste to landfill	Anode	kg	0,2	
Waste to recycling	Anode	kg	0,3	
Process yield	-	%	92	
Product Circularity Index	Anode	%	N/A	This KPI cannot be computed for intermediate products
Anode quality	Batch	%	8,5	Percentage of 30 minutes periods with lower anode density
Anode rejection rate	Anode	%	N/A	This KPI has not be computed during iteration 1 [5]
Acidification Potential	Anode	kg SO_2 equivalent	9	
Natural gas consumption	Anode	MJ	510	

[5] Aluminium Dunkerque fixed the target value for this indicator at 2,5%; second iteration of the project will explore the opportunity to compute the KPI and to include it in the Final Evaluation Framework

5.2 Evaluation Framework: plastic domain

In this section, an example of Evaluation Framework applied to plastic domain is reported for iteration 1 of the MONSOON project.

As this is an explanatory representation which aim is not to provide extended results, a sample reference time has been chosen. In particular, reported KPIs are referred to coffee capsules produced during 2017 in GLN facilities.

Table 6 - Evaluation Framework applied to plastic domain, (coffee capsules production, year 2017, GLN facilities). Green lines represent the base layer, blue lines contain domain-specific KPIs.

KPI name	Reference flow	Unit	KPI value	Comments
Global Warming	kg of capsules	kg CO_2 equivalent	2,7	
Primary Energy Consumption	kg of capsules	MJ equivalent	87	
Direct Energy Consumption	kg of capsules	MJ equivalent	8	
Electricity consumption	kg of capsules	MJ	8	
Raw material consumption	kg of capsules	kg	1,26	
Recycled content	kg of capsules	%	-	
Water Consumption	kg of capsules	l	18	
Waste to landfill	kg of capsules	kg	-	
Waste to recycling	kg of capsules	kg	0,26	
Process yield	-	%	79	
Product Circularity Index	capsule	%	17	
Rejection rate	kg of capsules	%	3	

6 Conclusions and developments

This deliverable introduces an initial set of specifications for the Evaluation Framework of the MONSOON project. After a description of the rationale behind the evaluation matrix, a description of the use cases investigated during iteration 1 has been reported; the structure of the Evaluation Framework has been depicted in Chapter 4, and an example of its application is presented in Chapter 0.

The most relevant outcome from the Initial Evaluation Framework is probably the set of KPIs to be used to monitor the effectiveness of MONSOON application to the industrial domains involved. The KPIs have been clustered in different classes, which combination allows to achieve a holistic perspective covering either process, environmental and usability aspects. Usability and replicability KPIs are not specified in this deliverable, for they will be defined according to the final shape of the whole MONSOON platform.

Two major steps are foreseen towards the final version of the Evaluation Framework. The first action is about the eventual integration of the KPI matrix into the MONSOON platform as an online component. At this stage, the Evaluation Framework has been designed by LCEN as a static component which is populated with results of offline calculations; an online integration of this component is likely to bring the project a higher level of robustness and would allow domain experts to actively monitor the effects of MONSOON.

The second action is about the graphical shape of the Evaluation Framework. At this stage, the component is in tabular form; an active representation based on dynamic dashboards might enhance the usability of the component and would allow to directly compare KPIs before and after the application of different MONSOON optimization techniques.

The next 6 months will be used by the MONSOON consortium to discuss, validate and modify the hypotheses presented in this deliverable. Modifications can be related to the KPIs, the way they are presented and the placement of the overall component in the MONSOON architecture; a dedicated task will be started to provide specification of the usability/scalability KPIs.

Acronym

Acronym	Explanation
KPI	Key Performance Indicator
LC	Life Cycle
LCA	Life Cycle Assessment
PCI	Product Circularity Index

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