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Optimal utilization of seafood side-streams through the design of new holistic process lines

Analytic Hierarchy Process (AHP) for the analysis of the viability of fish side streams valorisation

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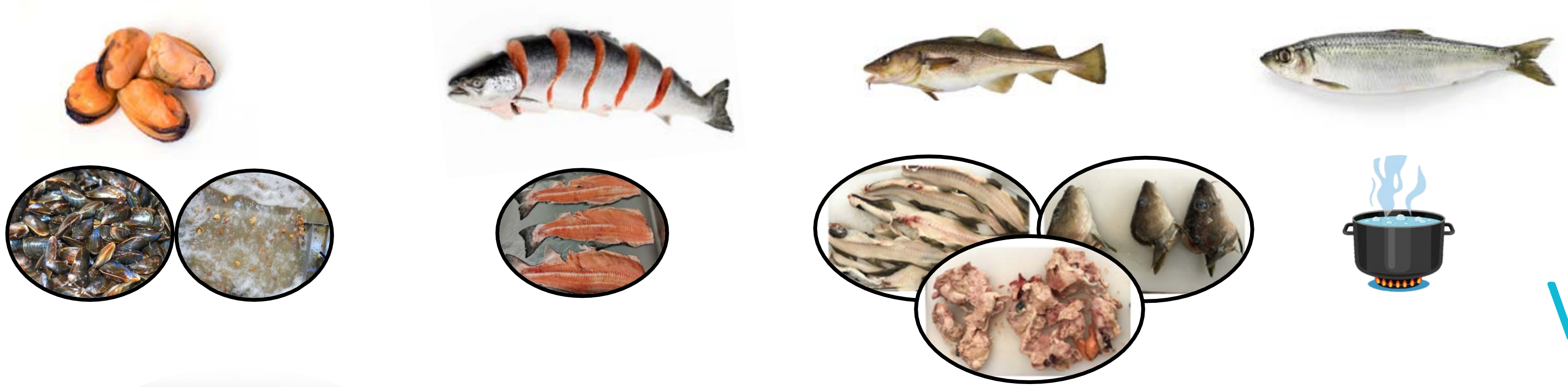
THE OBJECTIVE

Efficient and sustainable valorization system of seafood side-streams into MARKETABLE PRODUCTS

Up to 70 % end up as low-value products or waste

SIDE-STREAMS



VALUABLE END-PRODUCTS

Protein ingredients

Bioactive peptides

Mineral supplements

Savory compounds

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12. MARCELINO PESCADOS
13. JEKA FISH

CHALLENGE

Viability of valorisation alternatives when they are full-scale implemented

→

A great number of viability factors:

- Legal
- Technical
- Economic
- Environmental

→

High risk of underestimating some of these factors

→

Unprofitable implementation of these valorisation alternatives

↓

It is necessary to minimize that risk

→

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OBJECTIVE

- To help to take the right decision about waste-management strategies.

- To minimizes the inherent risk of a full-scale implementation of a new food waste valorisation facility.

AHP METHOD

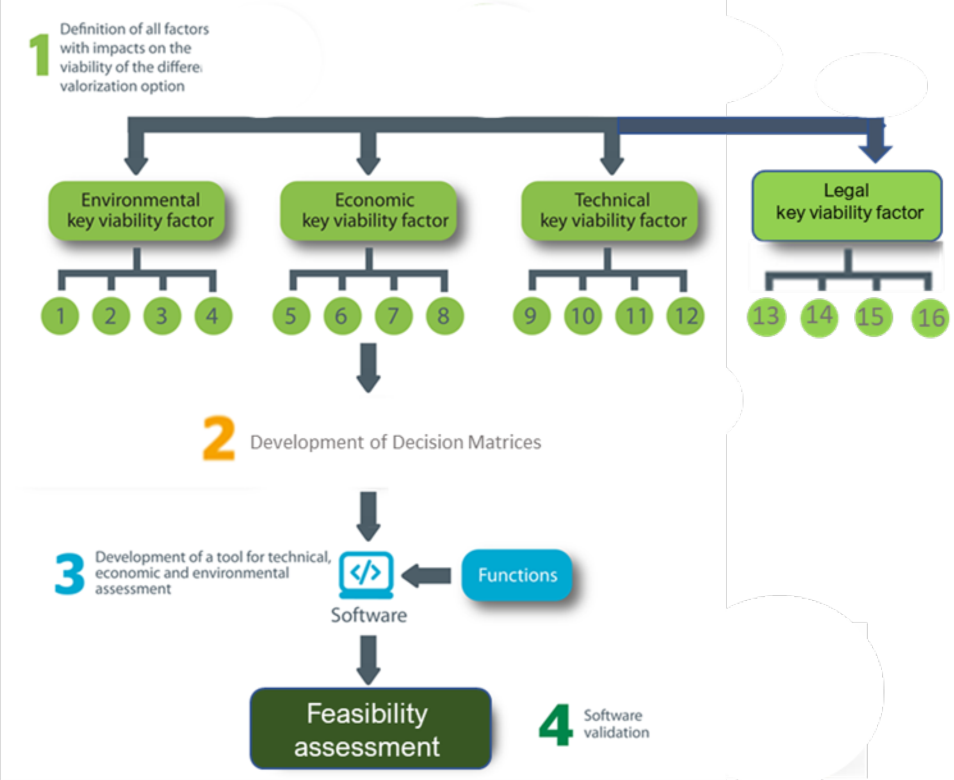
1.-Problem Definition

2.-Key Viability Factors
- -Relative importance
- -Limiting & conditional ranges
- -Matrix & rules decision

3.-Software programing

4.-Validation

AHP method



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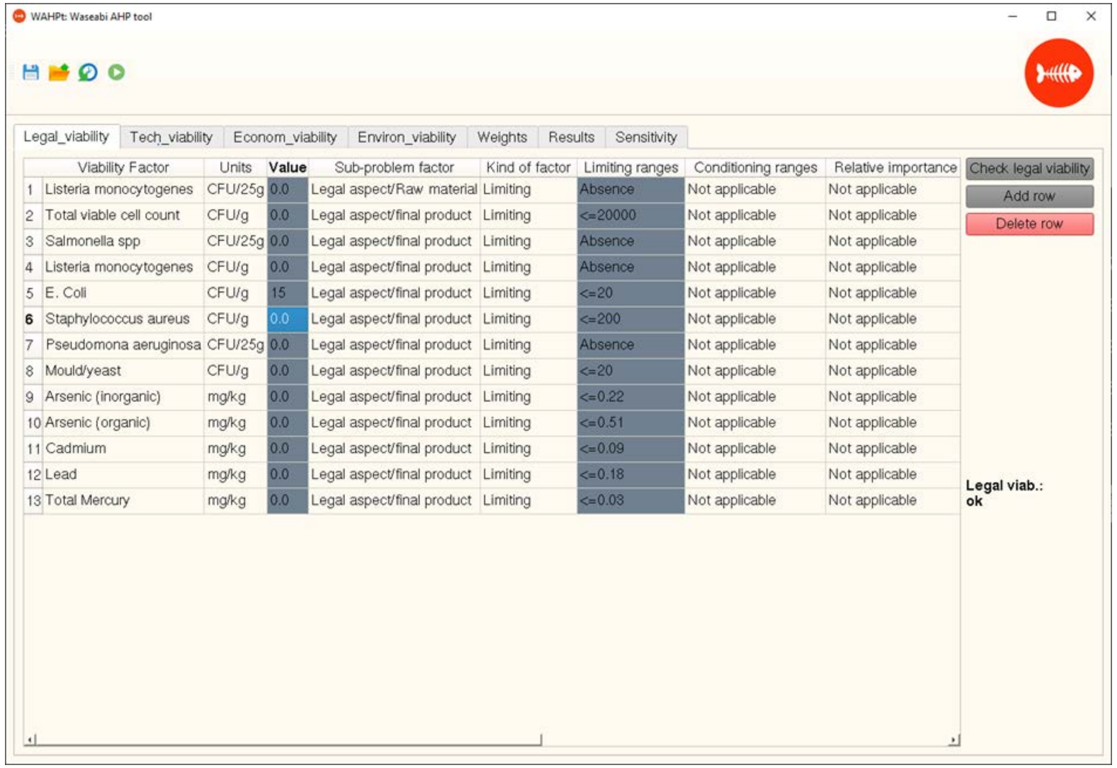
LEGAL VIABILITY



	Viability Factor	Units	Value	Sub-problem factor	Kind of factor	Limiting ranges	Conditioning ranges	Relative importance
1	Listeria monocytogenes	CFU/25g	0.0	Legal aspect/Raw material	Limiting	Absence	Not applicable	Not applicable
2	Total viable cell count	CFU/g	0.0	Legal aspect/final product	Limiting	<=20000	Not applicable	Not applicable
3	Salmonella spp	CFU/25g	0.0	Legal aspect/final product	Limiting	Absence	Not applicable	Not applicable
4	Listeria monocytogenes	CFU/g	0.0	Legal aspect/final product	Limiting	Absence	Not applicable	Not applicable
5	E. Coli	CFU/g	15	Legal aspect/final product	Limiting	<=20	Not applicable	Not applicable
6	Staphylococcus aureus	CFU/g	0.0	Legal aspect/final product	Limiting	<=200	Not applicable	Not applicable
7	Pseudomona aeruginosa	CFU/25g	0.0	Legal aspect/final product	Limiting	Absence	Not applicable	Not applicable
8	Mould/yeast	CFU/g	0.0	Legal aspect/final product	Limiting	<=20	Not applicable	Not applicable
9	Arsenic (inorganic)	mg/kg	0.0	Legal aspect/final product	Limiting	<=0.22	Not applicable	Not applicable
10	Arsenic (organic)	mg/kg	0.0	Legal aspect/final product	Limiting	<=0.51	Not applicable	Not applicable
11	Cadmium	mg/kg	0.0	Legal aspect/final product	Limiting	<=0.09	Not applicable	Not applicable
12	Lead	mg/kg	0.0	Legal aspect/final product	Limiting	<=0.18	Not applicable	Not applicable
13	Total Mercury	mg/kg	0.0	Legal aspect/final product	Limiting	<=0.03	Not applicable	Not applicable

- It allows to verify the **compliance of the studied side-stream of the legal viability constraints**.
- The output for this analysis is a simple binary result of the type True/False

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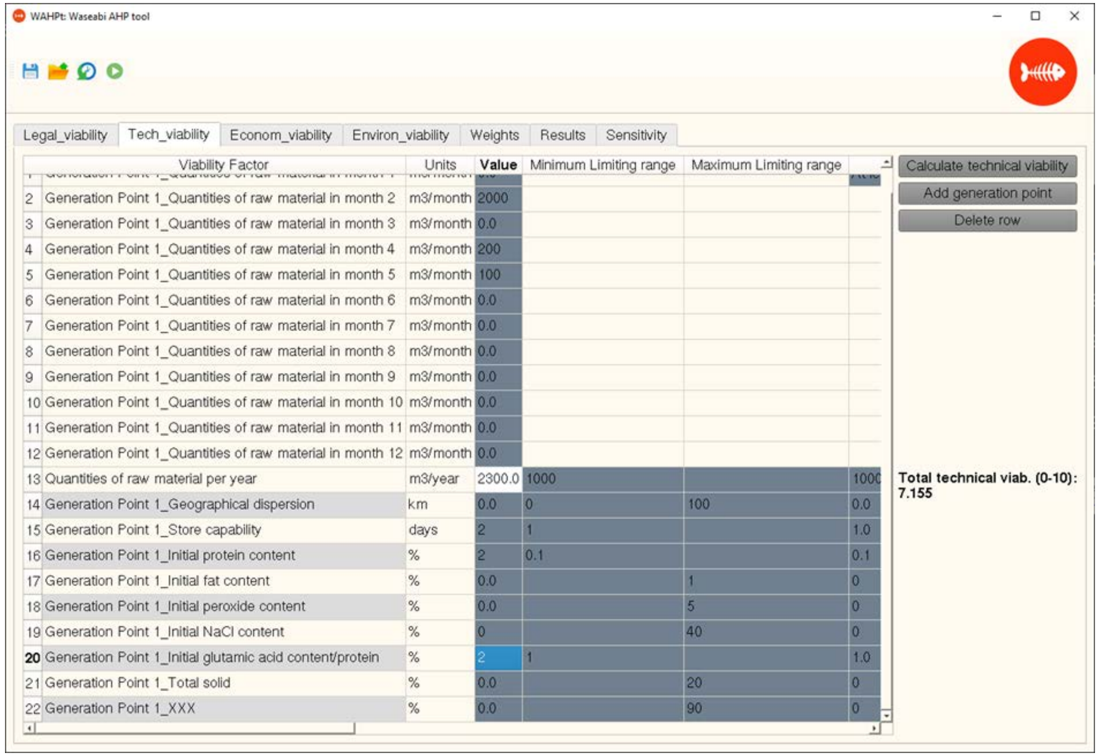
TECHNICAL VIABILITY



	Viability Factor	Units	Value	Minimum Limiting range	Maximum Limiting range	
2	Generation Point 1_Quantities of raw material in month 2	m3/month	2000			
3	Generation Point 1_Quantities of raw material in month 3	m3/month	0.0			
4	Generation Point 1_Quantities of raw material in month 4	m3/month	200			
5	Generation Point 1_Quantities of raw material in month 5	m3/month	100			
6	Generation Point 1_Quantities of raw material in month 6	m3/month	0.0			
7	Generation Point 1_Quantities of raw material in month 7	m3/month	0.0			
8	Generation Point 1_Quantities of raw material in month 8	m3/month	0.0			
9	Generation Point 1_Quantities of raw material in month 9	m3/month	0.0			
10	Generation Point 1_Quantities of raw material in month 10	m3/month	0.0			
11	Generation Point 1_Quantities of raw material in month 11	m3/month	0.0			
12	Generation Point 1_Quantities of raw material in month 12	m3/month	0.0			
13	Quantities of raw material per year	m3/year	2300.0	1000		1000
14	Generation Point 1_Geographical dispersion	km	0.0	0	100	0.0
15	Generation Point 1_Store capability	days	2	1		1.0
16	Generation Point 1_Initial protein content	%	2	0.1		0.1
17	Generation Point 1_Initial fat content	%	0.0		1	0
18	Generation Point 1_Initial peroxide content	%	0.0		5	0
19	Generation Point 1_Initial NaCl content	%	0		40	0
20	Generation Point 1_Initial glutamic acid content/protein	%	2	1		1.0
21	Generation Point 1_Total solid	%	0.0		20	0
22	Generation Point 1_XXX	%	0.0		90	0

- It consists of several **chemical indicators related to the potential of fish by-products for obtaining high value compounds**.
- The output is a positive number between 0 and 10, representing “0” a low technical viability and “10” a high technical viability.
- If a parameter is out of the limiting range, the score will be “0”, whereas if it is insides the limiting range, the score will be proportional to the conditional range.
- The score of each parameter viability is balanced by applying its relative importance to obtain a weighted score.

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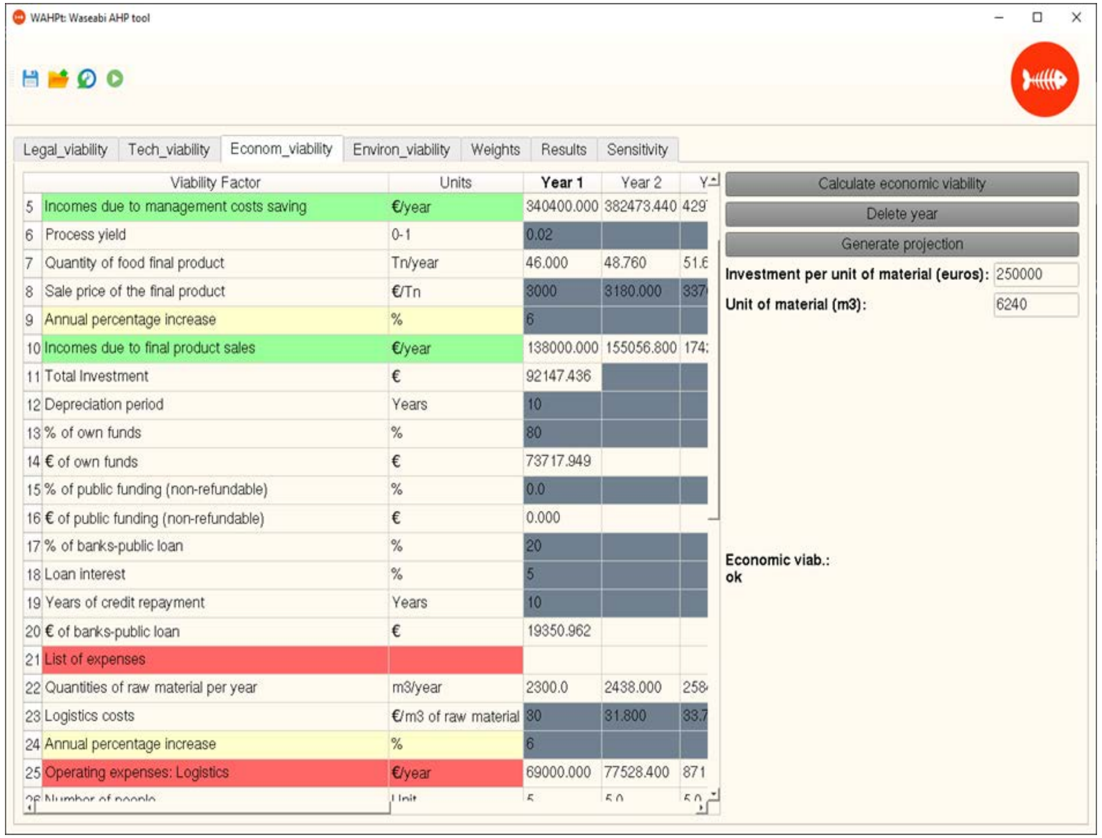
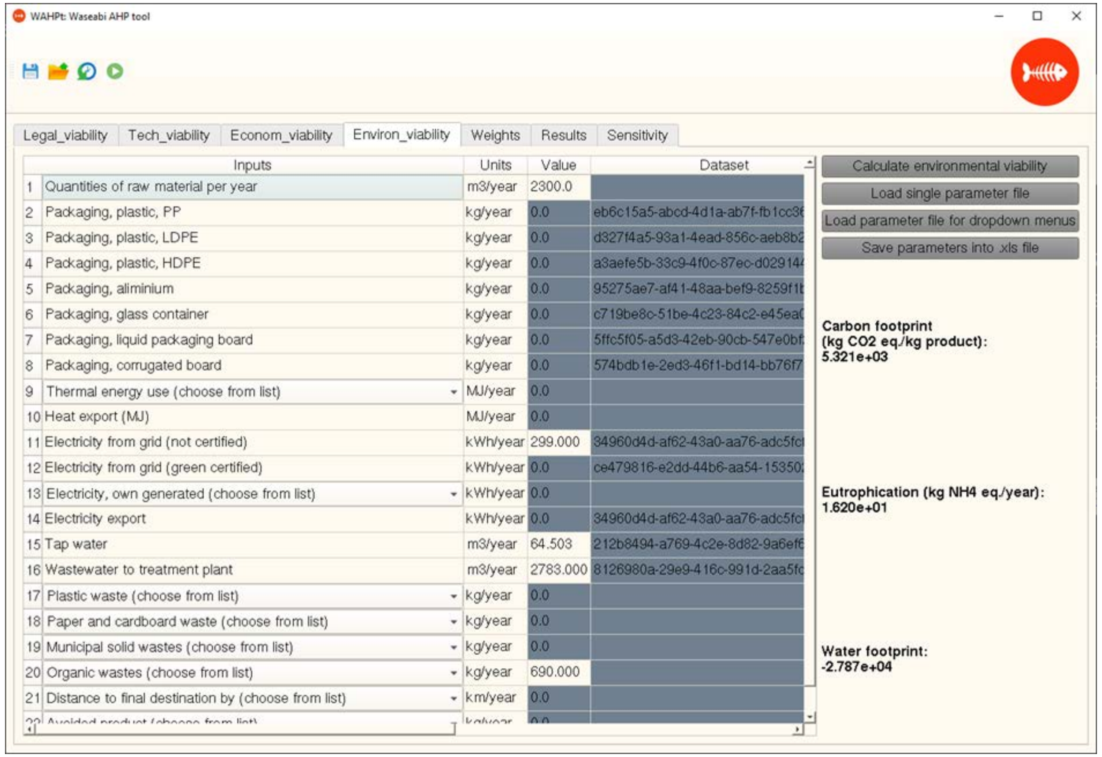
ECONOMICAL VIABILITY



- The economical parameters selected for the **economic analysis** are:
  - Net Present Value (NPV)
  - Return on investment (ROI)
  - Payback period (PP)
  - Gross Operation Profit (EBITDA).
- The number of years and the CAPEX and OPEX value for the calculation of the scenario can be modified by the user based on their experience.

ENVIRONMENTAL VIABILITY



- The environmental impacts selected for the **environmental assessment** are:
  - Carbon footprint
  - Water footprint
  - Eutrophication
- Based on a Life Cycle Assessment, the tool asks user data about the most important environmental aspects to calculate the selected impacts.

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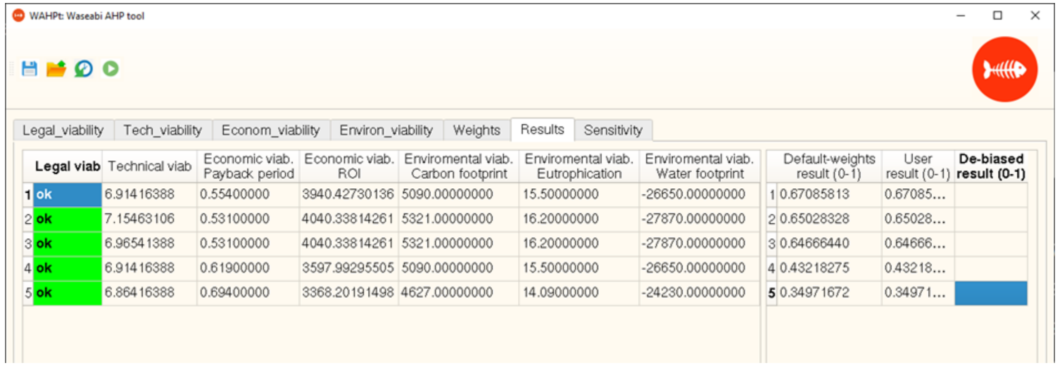
VIABILITY SCORE



	Legal viab	Technical viab	Economic viab. Payback period	Economic viab. ROI	Enviromental viab. Carbon footprint	Enviromental viab. Eutrophication	Enviromental viab. Water footprint		Default-weights result (0-1)	User result (0-1)	De-biased result (0-1)
1	ok	6.91416388	0.55400000	3940.42730136	5090.00000000	15.50000000	-26650.00000000	1	0.67085813	0.67085...	
2	ok	7.15463106	0.53100000	4040.33814261	5321.00000000	16.20000000	-27870.00000000	2	0.65028328	0.65028...	
3	ok	6.96541388	0.53100000	4040.33814261	5321.00000000	16.20000000	-27870.00000000	3	0.64666440	0.64666...	
4	ok	6.91416388	0.61900000	3597.99295505	5090.00000000	15.50000000	-26650.00000000	4	0.43218275	0.43218...	
5	ok	6.86416388	0.69400000	3368.20191498	4627.00000000	14.09000000	-24230.00000000	5	0.34971672	0.34971...	

- The **single score** is generated based on the relative weight given for each viability.
- If there are **more than one scenario**, one-score projection of the different viability calculations for different scenarios is included based on the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) technique.

  TOPSIS basic principle assumes that the chosen alternative should simultaneously have the shortest distance from the positive-ideal solution and the farthest distance from the negative-ideal solution.

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CONCLUSIONS

- AHP method is an appropriate methodology for **helping making decisions about waste management strategies**.
- This tool **assesses different scenarios with a minimum effort** and **minimize the time** required to evaluate the different scenarios under study.
- It will **help to define fish by-product valorisation strategies** reducing the effort, the environmental impacts and the costs comparing to the traditional procedure.

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Thank you for your attention!

Any question?

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