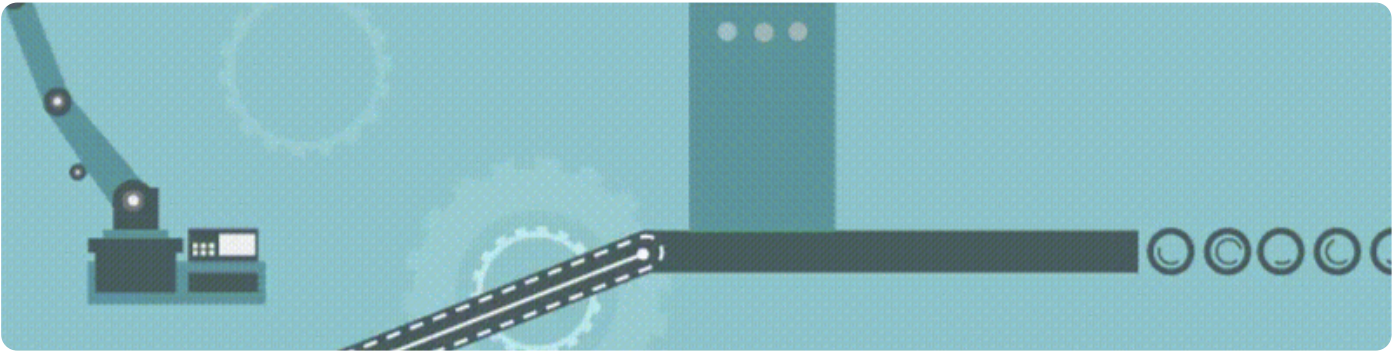




CISAMS Project - Validation of Circularity, Environmental, and Social Sustainability Indicators

Thank you for taking the time to participate in this survey. As part of the **Integrated Circularity and Sustainability Assessment of Manufacturing Systems (CISAMS) Project** (<https://cisams.eu/>), we aim to develop an integrated assessment method for manufacturing systems that encompasses circularity, environmental, and social sustainability aspects.

We have conducted an extensive literature review and developed a shortlist of key indicators for each of the three aforementioned aspects. To ensure these indicators are relevant, comprehensive, and practical, we seek your expert opinion. Your insights will significantly contribute to refining our assessment method.

This survey should take approximately **10-15 minutes** to complete. For the best experience, we recommend completing the survey on a PC or laptop, as it is not optimized for mobile or tablet use.

GDPR Statement

In accordance with the General Data Protection Regulation (GDPR) (EU) 2016/679, we are committed to ensuring the protection and privacy of your personal data.

By proceeding, you agree to the following:

- **Purpose of Data Collection:** Your responses will be used solely within the CISAMS Project for research purposes. No personal or identifiable data will be collected.
- **Confidentiality and Anonymity:** All responses will remain anonymous. Identifiable information cannot be inferred from the collected data.
- **Data Access and Retention:** All collected responses will be securely stored for the project duration and used solely for research purposes. After any mandatory archiving period, the data will be permanently deleted.
- **Right to Withdraw:** You may withdraw at any time by contacting us at arent@mail.ntua.gr or aretoulaki@mail.ntua.gr. Upon withdrawal, your responses will be removed from our records.

We appreciate your valuable input in advancing this important research.

Acknowledgment: This project is carried out within the framework of the National Recovery and Resilience Plan Greece 2.0, funded by the European Union – NextGenerationEU (Implementation body: HFRI | Project Number: 16148).

Which area(s) best describe(s) your expertise? (Select all that apply)

- ☐ Academic
 - ☐ Manufacturing/Production
 - ☐ Environmental, Social, and Governance (ESG)/Sustainability
 - ☐ Supply Chain & Logistics
 - ☐ Waste Management & Recycling
 - ☐ Energy & Resource Management
 - ☐ Industrial Innovation & Technology
 - ☐ Policy & Regulation
 - ☐ Other
-

How many years of experience do you have in the following sectors?

	None	Less than 5 years	5-10 years	10-20 years	More than 20 years
Manufacturing	☐	☐	☐	☐	☐
Circular Economy	☐	☐	☐	☐	☐
Environmental Sustainability	☐	☐	☐	☐	☐
Social Sustainability	☐	☐	☐	☐	☐



Circularity Indicators

We have compiled **51 circularity indicators**, organized into the **9 categories** in the list below.

👉 This survey aims to assess the relative importance of different circularity indicators. Instead of rating each individually, you will use a Best-Worst Method (BWM) approach to compare their categories against each other.

1 Step 1: Select the Most and Least Important Circularity Indicator Categories

First, you will choose the most important (Best) and least important (Worst) circularity indicator category based on your expertise.

2 Step 2: Compare the Best Indicator Category Against Others

You will then compare your Best Indicator Category to all others, using a scale from 1 to 9.

1 = Equal importance

9 = Best Indicator category is Extremely More Important than the other indicator category.

3 Step 3: Compare Others Against the Worst Indicator Category

Finally, you will compare each of the other indicator categories against the Worst Indicator Category.

Again, use a scale from 1 to 9, where 9 means the indicator category is Extremely More Important than the Worst.

✅ **Example to Help You Understand:**

If you think “Recycling Performance” is the most important and “Reuse, Remanufacturing & Refurbishment” is the least important:

You will rate how much more important "Recycling Performance" is compared to each of the other 8 categories.

Then, you will rate how much more important each of the other 8 categories is compared to "Reuse, Remanufacturing & Refurbishment".

✳️ Please take your time and provide the most accurate answers based on your expertise.

Need more details? If you want to see the specific circularity indicators within each category and their definitions, [click here](#) for more information before making your selections and proceeding with comparisons.



From the list below, which **Circularity Indicator** category do you consider the **most important** for assessing circularity in manufacturing systems?

Choose

▼

From the list below, which **Circularity Indicator** category do you consider the **least important** for assessing circularity in manufacturing systems?

Choose

▼

Best-to-Others Comparison

How much more important is the **Best Circularity Indicator** category you selected compared to each of the following categories?

Now, compare the **Best Circularity Indicator** category you selected against each of the others. Use the scale to indicate how much more important the **Best Circularity Indicator** category is compared to each one (**1 = Equal, 9 = The Best Indicator Category is Much More Important**). **Tip:** Always put "1" when comparing the Best Indicator category to itself.

[illegible]

Efficiency & Value

Performance - Measures the relationship between resource inputs, material losses, and value creation to maximize resource productivity



Waste Generation & Management - Assesses the quantity, composition, and treatment of waste, focusing on minimizing losses and enhancing recovery strategies



Recycling Performance - Evaluates the effectiveness, yield, and resource efficiency of recycling processes to retain materials in productive use



Resource Retention & Product Lifespan - Evaluates how long and effectively materials and products are retained in use across cycles, minimizing value loss through waste, downcycling, and dissipation



Others-to-Worst Comparison

How much more important is **each Circularity Indicator** category compared to the **Worst Circularity Indicator** category you selected?

Now, compare each **Circularity Indicator** category against the **Worst Circularity Indicator** category you selected. Use the scale to indicate how much more important each one is compared to the Worst (**1 = Equal, 9 = This Indicator Category is Much More Important than the Worst**). **Tip:** Always put "1" when comparing the Worst Indicator category to itself.

[illegible]

Efficiency & Value

Performance - Measures

the relationship between resource inputs, material losses, and value creation to maximize resource productivity



Waste Generation &

Management - Assesses

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Recycling Performance -

Evaluates the effectiveness, yield, and resource efficiency of recycling processes to retain materials in productive use



Resource Retention &

Product Lifespan -

Evaluates how long and effectively materials and products are retained in use across cycles, minimizing value loss through waste, downcycling, and dissipation

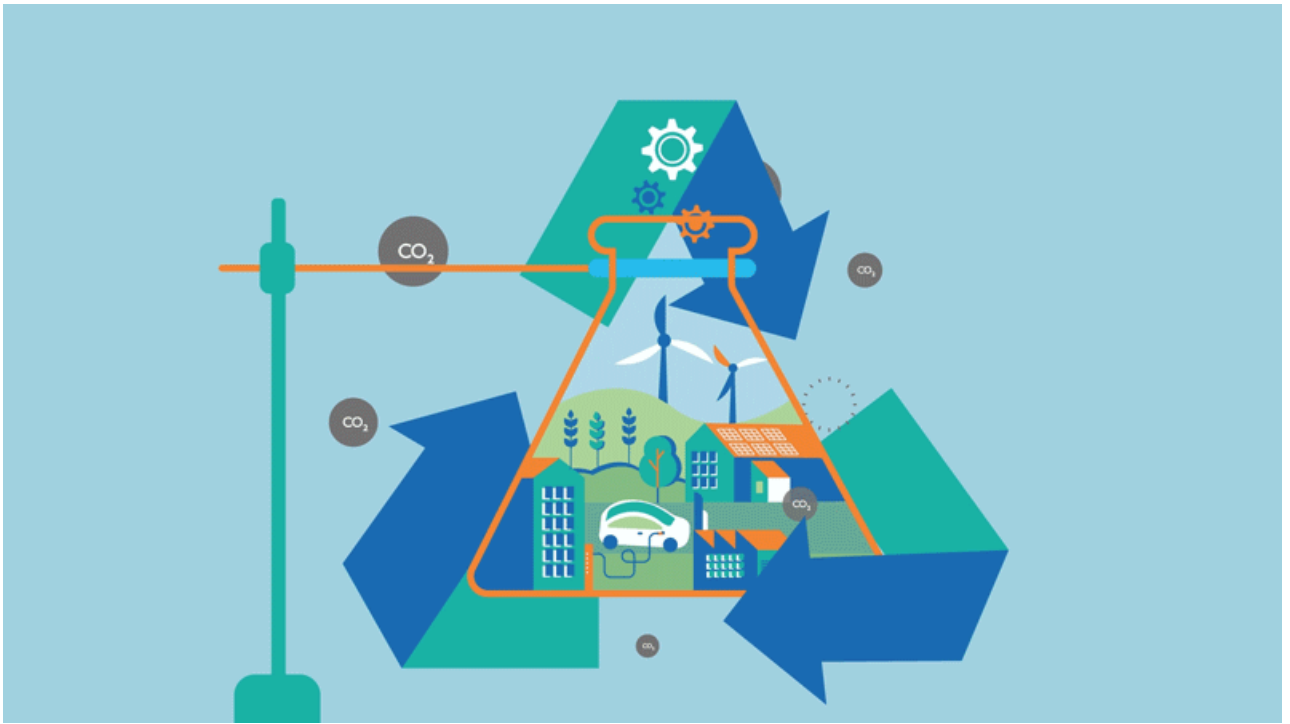


Funded by the
European Union
NextGenerationEU

Environmental Sustainability Indicators

We have compiled **32 environmental sustainability indicators**, organized into the **9 categories** below.

Need more details? If you want to see the specific environmental sustainability indicators within each category and their definitions, [click here](#) for more information before making your selections and proceeding with comparisons.



From the list below, which **Environmental Sustainability Indicator** Category do you consider the **most important** for assessing environmental sustainability in manufacturing systems?

Choose

From the list below, which **Environmental Sustainability Indicator** Category do you consider the **least important** for assessing environmental sustainability in manufacturing systems?

Choose

Best-to-Others Comparison

How much more important is the **Best Environmental Sustainability Indicator** category you selected compared to each of the following categories?

Now, compare the **Best Environmental Sustainability Indicator** category you selected against each of the others. Use the scale to indicate how much more important the **Best Environmental Sustainability Indicator** category is compared to each one (**1 = Equal, 9 = The Best Indicator Category is Much More Important**). **Tip:** Always put "1" when comparing the Best Indicator category to itself.

[illegible]

Material Sustainability -
Measures the environmental compatibility of materials, considering their degradation characteristics and long-term ecological impacts



Resource Use, Scarcity & Depletion - Assesses the consumption of natural resources like water, energy, and raw materials, highlighting risks of depletion and environmental strain



Toxicity & Eutrophication -
Measures the potential of industrial activities to cause harm to human health, ecosystems, and water bodies through toxic emissions and nutrient pollution



Water Management -
Evaluates water consumption, wastewater treatment, and water use efficiency to minimize environmental impacts on freshwater systems



Others-to-Worst Comparison

How much more important is each **Environmental Sustainability Indicator** category compared to the **Worst Environmental Sustainability Indicator** category you selected?

Now, compare each **Environmental Sustainability Indicator** category against the **Worst Environmental Sustainability Indicator** category you selected. Use the scale to indicate how much more important each one is compared to the Worst (**1 = Equal, 9 = This Indicator Category is Much More Important than the Worst**). **Tip:** Always put "1" when comparing the Worst Indicator category to itself.

[illegible]

Material Sustainability -

Measures the environmental compatibility of materials, considering their degradation characteristics and long-term ecological impacts

☐☐☐☐☐☐☐☐☐

Resource Use, Scarcity & Depletion -

Assesses the consumption of natural resources like water, energy, and raw materials, highlighting risks of depletion and environmental strain

☐☐☐☐☐☐☐☐☐

Toxicity & Eutrophication -

Measures the potential of industrial activities to cause harm to human health, ecosystems, and water bodies through toxic emissions and nutrient pollution

☐☐☐☐☐☐☐☐☐

Water Management -

Evaluates water consumption, wastewater treatment, and water use efficiency to minimize environmental impacts on freshwater systems

☐☐☐☐☐☐☐☐☐

Social Sustainability Indicators

We have compiled **40 social sustainability indicators**, organized into the **7 categories** below.

Need more details? If you want to see the specific social sustainability indicators within each category and their definitions, [click here](#) for more information before making your selections

and proceeding with comparisons.



From the list below, which **Social Sustainability Indicator** Category do you consider the **most important** for assessing social sustainability in manufacturing systems?

Choose



From the list below, which **Social Sustainability Indicator** Category do you consider the **least important** for assessing social sustainability in manufacturing systems?

Choose



Best-to-Others Comparison

How much more important is the **Best Social Sustainability Indicator** category you selected compared to each of the following categories?

Now, compare the **Best Social Sustainability Indicator** category you selected against each of the others. Use the scale to indicate how much more important the **Best Social Sustainability Indicator** category is compared to each one (**1 = Equal, 9 = The Best Indicator Category is Much More Important**). **Tip:** Always put "1" when comparing the Best Indicator category to itself.

[illegible]

placement, policy influence,
and philanthropy

Others-to-Worst Comparison

How much more important is each **Social Sustainability Indicator** category compared to the **Worst Social Sustainability Indicator** category you selected?

Now, compare each **Social Sustainability Indicator** category against the **Worst Social Sustainability Indicator** category you selected. Use the scale to indicate how much more important each one is compared to the Worst (**1 = Equal, 9 = This Indicator Category is Much More Important than the Worst**). **Tip:** Always put "1" when comparing the Worst Indicator category to itself.

	1	2	3	4	5	6	7
Employment Practices -							
Measures job creation, equal opportunities, and diversity in the workforce	☐	☐	☐	☐	☐	☐	☐
Labor Standards & Workplace Conditions -							
Measures workplace safety, working hours, environmental stressors, and ergonomic factors	☐	☐	☐	☐	☐	☐	☐
Fair Compensation & Benefits - Measures fair wages, essential benefits, and additional financial incentives for workers	☐	☐	☐	☐	☐	☐	☐
Ethical Practices -							
Measures risks of child labor, forced labor, and ethical standards in the supply chain	☐	☐	☐	☐	☐	☐	☐
Health & Safety - Measures workplace injuries, social security, occupational hazards, and lost workdays	☐	☐	☐	☐	☐	☐	☐
Governance & Reporting -							
Measures corporate social responsibility, governance, and regulatory compliance	☐	☐	☐	☐	☐	☐	☐
Impacts on Society -	☐	☐	☐	☐	☐	☐	☐
Measures job creation in circular economy industries, community engagement, ethical trade, facility							

placement, policy influence,
and philanthropy



Final Feedback

We value your expertise and welcome all feedback. Please share any suggestions for additional categories, specific indicators, or general comments you believe are crucial for enhancing our assessment framework.