CISAMS: Integrated Circularity and Sustainability Assessment of Manufacturing Systems

Deliverable 4: Integrated circularity and sustainability assessment method

Greece 2.0
Basic Research Financing Action
(Horizontal support of all Sciences)
Sub-action 1: Funding New Researchers

M22

H.F.R.I. Hellenic Foundation for Research & Innovation
Greece 2.0 NATIONAL RECOVERY AND RESILIENCE PLAN
Funded by the European Union NextGenerationEU

Document control sheet

Project	Integrated Circularity and Sustainability Assessment of Manufacturing Systems
Call identifier	Greece 2.0 Basic Research Financing Action (Horizontal support of all Sciences) Sub-action 1 Funding New Researchers
Grant Agreement N°	16148
Coordinator	National Technical University of Athens
Work package	WP4 – Integrated circularity and sustainability assessment method development
Work package leader	Athanasios Rentizelas
Related Milestones	MS4: Selection of appropriate MCDA method for integrated C&S assessment method
Deliverable title	Integrated circularity and sustainability assessment method
Deliverable nature	R
Dissemination level	CO
Authors	Kostas Florios, Efthymios Simos, Athanasios Rentizelas, Eleni Aretoulaki
Version	1.0
Total number of pages	93
Issue date	31/12/2025

REVISION HISTORY			
Version	**Date**	**Author(s)**	**Changes made**
0.1	01/12/2025	Kostas Florios, Efthymios Simos, Eleni Aretoulaki	Draft version
1.0	31/12/2025	Athanasios Rentizelas, Kostas Florios, Efthymios Simos, Eleni Aretoulaki	Final version after review

1 EXECUTIVE SUMMARY

In this deliverable, the Integrated circularity and sustainability assessment method is presented. The results from the independent assessment of Circularity (C), Environmental Sustainability (ES) and Social Sustainability (SS) that were obtained in the work packages 1-3 are used in an integrated ranking method in order to obtain a final ranking of the alternatives combining information from all three pillars. We recall that the independent assessment of C, ES and SS takes place in two steps: a) the Bayesian Best Worst Method (BBWM) is used in order to obtain the weights for each indicator category within each pillar C, ES and SS, and b) the PROMETHEE-II method is used in order to independently rank the alternatives for each pillar C, ES and SS. The outcome of PROMETHEE-II is the net-flow for each alternative, which results in three different rankings according to C, ES and SS, separately and independently.

In this deliverable, we start from these three distinct rankings and attempt to integrate them into one unique ranking. The Analytic Hierarchy Process (AHP) is used for this purpose. The input matrix to the AHP contains the Circularity Index (CI), Environmental Sustainability Index (ESI) and Social Sustainability Index (SSI) as columns and has the several alternatives as rows. The three composite indices CI, ESI and SSI are the net-flows associated with each alternative from the PROMETHEE-II application to the pilar C, ES and SS, respectively. We take care to rescale the real numbers between [-1, 1] that constitute the new flows to the range [0, 100] of positive integers. Then the AHP method proceeds with its two steps: i) compute the weight from each pillar C, ES and SS using information supplied by the owner of the case study, by which they express their preferences between pillars C, ES and SS by pairwise comparisons and ii) implement a weighted sum method to combine the three Composite Indices CI, ESI and SSI to a unique priority score (PS) according to which the final integrated ranking is obtained by the AHP method. The application of the integrated circularity and sustainability assessment method is illustrated via the use of 2 Case Studies: first, the Plastics (PVC) extrusion and second, the Aluminium Production applications. The description of the alternatives and the indicators for each case study is comprehensive, before we dive in the numerical application of the AHP method for each. Results are obtained and the final ranking is commented upon. We conclude that the AHP method helps assess the alternatives integrating information from all three pillars, but it does not guarantee that high ranking alternatives are efficient in the sense of Pareto Optimality. This task is to be undertaken in Deliverable 5.